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RAILS WEIGHING 200 LBS. PER YD. are *not* contemplated by the Metropolitan Ry., of London, or any other railway known to this journal. The statement to that effect on page 113 of our last issue was due to a compositor's blunder, combined with the fact that the item escaped the notice of the editing proofreader. The "bulb-head" rail section referred to in the same item is another contribution to engineering science by the same ingenious compositor. What the Metropolitan Ry. *is* now proposing to introduce is a bull-head rail weighing 100 lbs. per yd., and Mr. C. P. SANDBERG has been consulted concerning its proper design.

THE "HURONTARIO" SHIP RAILWAY PROJECT, to connect Georgian Bay with Lake Ontario at Toronto, seems to be showing signs of life.

The distance between Lake Huron and the mouth of the River Humber, west of Toronto, is 69 miles. The summit level would be 661 ft. above Lake Ontario, and 327 ft. above Lake Huron, the difference of level of the two lakes being 334.7 ft. (581.3 — 246.6) by the latest surveys. The heaviest grade south of the ridges would be 30 ft. per mile, and north of the ridges 20 ft. per mile. The railway would cross the ridge at 327 ft. above Georgian Bay. The ship railway would have to cross five railways on the way to Ontario, over which viaducts would have to be constructed. The lift locks are proposed to be 270 ft. in length, 35 ft. in width, 14 ft. on the sills, and 50 ft. in height, with protecting harbors at each terminus and four turntables at certain points along the route to enable vessels to pass each other. Three railway tracks of the ordinary 4 ft. 8½ in. gauge, with from 100 to 110 lbs. per yd., are proposed. The total cost is estimated at $12,000,000, being one-half the cost of a ship canal of the same capacity. It is claimed that three large locomotives would transport a vessel of 2,000 tons weight, including vessel and cargo, or more than 1,000 tons register, at the rate of 10 miles per hour. The ship railway would save 428 miles of lake navigation and 28 miles of canal between Chicago and Montreal. A liberal subsidy is the first and most urgent necessity.

AN AIR-BRAKE INSTRUCTION TRAIN of freight cars is being fitted up at the Columbus shops of the Pennsylvania southwest system, at the suggestion of Mr. E. B. WALL, Superintendent of Motive Power. The train will be run over the various divisions of the system, giving all the trainmen an opportunity to become familiar with the manner of operating air brakes. The train will consist of the average number of freight cars, thoroughly equipped with air brakes. A passenger coach will probably be coupled in the middle of the train. The freight crews, as yet, of course, have a very imperfect understanding of the air brake, despite the large number of freight cars already equipped, and it is an encouraging sign of progress that it has become necessary to systematically instruct them.

THE AUSTRIAN ZONE SYSTEM OF PASSENGER TARIFF has been slightly modified from the form given in ENGINEERING NEWS of July 12. The second 100 kilos. is now divided into 4 zones instead of 2 as formerly, and a few special rates are allowed. Children under 2 years are carried free, those between 2 and 10 years pay half fare, and pupils of the public schools are allowed half rates on distances under 50 kilos. (31 miles). Working people traveling third-class receive certain reductions, and criminals and their guards are transported at half price.

RAILWAY RATES IN KANSAS MUST COME DOWN.—The Board of Railroad Commissioners has issued an order cutting down the local distance tariff of rates on grain and grain products about 32 per cent. and on the other articles about 10 per cent.

THE FIRST ELECTRIC FREIGHT RAILROAD is projected at Fall River, Mass. It will be a belt line reaching the principal mills. The scheme is said to be backed by the Thomson-Houston Co.

FANS DRIVEN BY ELECTRIC MOTORS are to be put up in parlor cars of the Chicago & Alton, according to report.

NEW BALTIMORE & OHIO SHOPS are to be built at Cumberland, Md. A contract has just been closed between the railway company and the city of Cumberland, by which, in consideration of a subsidy of $150,000 voted by the city, the company agrees to build extensive shops there, costing with machinery not less than $150,000. The work is to be completed within two years.

THE WORST ACCIDENT OF THE WEEK was again a head collision, this time on the Auburn Division of the New York Central R. R. The trains were a regular freight and an extra freight, and the train dispatcher "forgot" to hold the extra for the regular train to pass it. Two trainmen were killed and three were seriously injured. Another serious head collision occurred Aug. 7, near Sherman, Tex., between a passenger train and a wild engine One man was killed and five were badly hurt. Other head collisions have occurred on the Louisville, Evansville & St. Louis, Jacksonville, Southeastern, Louisville & Nashville, and Pittsburgh, Ft. Wayne & Chicago. A number of rear collisions are also reported.——The Louisville, New Albany & Chicago has had another slight accident resulting in noth ing more serious than smashing a borrowed engine. ——A lamp exploded in a Grand Trunk sleeping car Aug. 9 and the car was burned. The passengers escaped.——A colonist sleeper on the Great Northern was burned near Ada, Minn., Aug. 10. The cause of the fire is not given.

THE ST. CLAIR TUNNEL is rapidly approaching completion. At 8 A. M. on Saturday, Aug. 9, the shields were only 439.5 ft. apart, the progress made during the preceding week having been 158.9 ft., so that at this rate the headings should meet in less than a fortnight from the date of this issue. The complete tunnel will be 6,050 ft. long (2,300 ft. of which is under the river bed), so that 5,610.5 ft. has now been completed, or 93 per cent. of the whole. The extreme rapidity with which the work has been pushed, which is quite without parallel, and which reflects the highest credit upon the chief engineer, Mr. JOSEPH HOBSON, Chief Engineer Grand Trunk Ry., is evidenced by the fact that the last issue of the *Scientific American* dated Aug. 9, reports only 4,550 ft. as completed, or 1,060.5 ft. less than was actually completed on that date; this great difference, however, being only a little more than six weeks' work. The tunnel proper was not begun till August, 1889; and another remarkable fact about it is that it bids fair to cost less than the estimated cost of $3,000,000.

THE HARLEM RIVER SHIP CANAL is strongly favored by Controller MYERS, of New York City who has written a long letter to the Senate Committee urging that the $350,000 appropriation for this work, which was struck out of the River and Harbor bill be replaced. There is much to be said both for and against the completion of the work, What seems to be needed is a comparison by experts between the benefits to be gained by the construction of the canal and the loss and delay which will inevitably result to the railway and street traffic which must go under or over it.

THE CHESAPEAKE & OHIO CANAL receivers in the District of Columbia, take a position opposite to that of the Maryland receivers in their report. They recommend that the canal be repaired and put in operation. The presidents of coal companies have assured the receivers that 450,000 tons of coal per annum will be sent over the canal if it is repaired. With this and other certain business the receivers think a gross income of $250,000 per annum can be realized, or a net income of $120,000 per annum above operating expenses.

THE WIND LAKE DRAINAGE CANAL, the largest in Wisconsin, has just been completed. It is 15 miles long, and cost $40,000. About 13,000 acres are reclaimed by its completion.

THE NEWARK (N. J.) AQUEDUCT BOARD has voted to employ an engineer of national reputation to serve as consulting engineer in connection with the engineer to the board during the construction of the new works.

THE FIRST SUCCESSFUL ARTESIAN WELL IN NEW MEXICO has been bored at Springer, in the northwestern part of the territory. The water was struck at a depth of 250 ft.

THE SECOND BASIN of the new Covington waterworks reservoir, described and illustrated in our issues of May 10 and 17, has been completed.

AN IMPORTANT WATER-POWER SCHEME is reported at Macon, Ga. Consulting Engineer B. S. CHURCH has made a report to Mr. J. C. MCBURNEY, of Atlanta, President of the Macon Canal and Mfg. Co., advising the construction of a canal 50 ft. wide on top, 30 ft. at the bottom and 10 ft. in depth, with a flow of 1,288 cu. ft. per minute. The effective head is 48 ft., which will give about 6,000 actual HP. after taking out the water needed for the city supply. He also suggests that power can be electrically transmitted to various manufactories in the city, and electric light for streets and residences can be furnished cheaper than gas. The length of the canal would be about 10 miles. The cost is estimated at $313,000. He also says that about $90,000 should be expended to build two distributing reservoirs and lay 50 miles of street mains for the water-works.

EXTENSIVE IRON WORKS at Middlesborough, Ky., near Cumberland Gap, are projected by the South Boston Iron Works, which are likely to end in the transfer of the entire business of the company to this point. The works are for the manufacture of ordnance and heavy machinery, and will be of the most complete modern type, including a series of four to six basic open-hearth furnaces. English capital is largely interested in the project, which is a mere project no longer, the works being under way.

POWER DISTRIBUTION BY A PARTIAL VACUUM as well as by compressed air is practiced in Paris. The central station is provided with three 100 HP. Corliss engines which operate the pumps. These exhaust the air in the chambers to which the mains lead. The latter are cast iron pipes varying from 4 ins. to 1 ft. in diameter and are connected with the motors by lead service pipes. The partial vacuum is kept practically constant in the mains and chambers. The motors are cylinder vacuum engines of from 68 to 80 per cent. efficiency and occasionally as high as 1.5 HP. The cost per HP. hour is about 23 cents. The station supplies power to nearly 200 shops within a radius of a half mile.

The Jordan Bridge Guard.

The Jordan bridge guard, shown by the engravings herewith, proceeds on a quite different principle from the Latimer and other safety bridge guards of that type, by assuming that the best and safest course, when derailed wheels strike the bridge, is simply to prevent the bridge from making a bad matter worse, by holding the wheels where they are until they have passed the bridge, rather than to attempt to replace them on the rails. For both of these courses something is to be said; both have proved useful in practice; neither to our knowledge has ever worked mischief. We have often presented the claims of the rerailing type; we propose now to present the claims of the parallel or *in statu quo* type, of which the Jordan bridge guard is the most prominent and successful example. We have no quarrel with either type, nor with those who prefer either; but only with those who will neither use the one nor the other, nor any equivalent.

The Jordan guard is the invention of Mr. O. F. JORDAN, Roadmaster of the Canada Southern Division of the Michigan Central Railway, and is now standard on the Michigan Central Railway. All bridges on that line of 20 ft. span or over are being equipped with it as fast as is conveniently possible. It is based largely on the experience covered by the accompanying large table, recording the derailments which occurred on that road between March 1, 1884, and Feb. 13, 1890.

To this statement we have added the analysis which appears below it, and which will bear careful study. This fact should be remembered, however, in connection with any derailment statistics of the Canada Southern Ry., that it probably has less curvature than any other of its length in this country, if not in the world. Practically, there are no curves on it, the few that occur being all of extremely easy radius. Therefore, derailed wheels have a much better chance there than elsewhere to run a long distance without working off far from the rails, but even with this proviso the showing of the table is remarkable.

It will be seen, in the first place, that in no less than 12 instances out of 66 (the total of all derailments) the trucks ran *over a mile* derailed, and in three instances nearly 5 miles, before the train was stopped or wreck occurred. In six more derailments trucks ran from one-quarter mile to a mile; in three other derailments from 180 to 540 ft. In all, in 21 instances, the derailed trucks ran considerable distances, against 45 in which they ran but a short or unrecorded distance. These figures clearly show that in certain large classes of derailments the trucks tend of themselves to "follow" pretty well; and moreover, that if they tend to follow well at all, they are more likely than not to run long distances off the rails. There were just six times as many cases where trucks ran ¼ mile to 5 miles as there were of cases where they ran less than ¼ mile and yet a measurable distance.

Moreover, the causes from which the derailments occur, are also well worthy of careful study; and here also it is necessary to remember that the Canada Southern Ry. is somewhat of an exception. Being a well-ballasted and well-maintained straight line, so to speak, the causes likely to produce derailments are naturally confined for the most part to car breakages. But after all proper allowance is made for this difference (and it should be considerable) there still remains a quite abnormal contrast between the recorded experience of the Canada Southern and that of the country as a whole, which is at least surprising, and which may be in part due to the misclassification of the causes of accidents on the Canada Southern Ry., there being very often great difficulty in discovering an actual cause, and in distinguishing cause and effect. Under these circumstances, there is a natural tendency to ascribe the accident to the first broken (or the worst broken) part discovered, when it may have had nothing whatever to do with it; and it is a very common experience to find the track department reports of an accident ascribing it to some rolling stock defect, while the mechanical department reports of the very same accident, ascribe it to some track defect, both reporting in perfect good faith, and influenced only by an unconscious bias, if any.

That some misclassification of this kind may have crept into the accompanying table becomes at once evident when we compare the reported Canada Southern experience with that of the whole United States for the 13 years, 1873-1885, as follows:

	C. S. R.		U. S., 1873-85.	
Causes of derailments.	No.	Per cent.	No.	Per cent.
Broken axle	18	27.3	479	5.3
Broken wheel	11	16.6	354	3.9
Loose wheels	4	6.1	22	0.2
Broken trucks	6	9.1	157	1.7
Broken brake gear	8	12.1	23	0.3
Total truck failures	47	71.2	1,035	11.4
Broken draw gear	3	4.5	38	0.4
Engine breakages	4	6.1	10	0.1
Other rolling stock failures	..	....	11	0.1
Total rolling stock failures	54	81.8	1,094	12.0
Frogs and switches	6	9.1	1,165	12.9
Broken rails	4	6.1	842	9.3
Accidental obstruction	2	3.0	459	5.1
Unexplained	..	....	2,850	31.4
All others	..	....	2,655	29.3
Grand total	66	100.0	9,065	100.0

It will be seen that the Canadian Southern experience shows just 50 per cent. of derailments to come from wheel and axle failures, whereas average experience shows only 9.4 per cent.; it also shows 7.12 per cent. of truck failures of all kinds against only 11.4 per cent. in general experience, and not less than 81.8 per cent. of rolling stock failures of one kind or another against only 12 per cent. as an average of the experience of the whole United States for a period of 13 years.

Now it will be at once seen that this broad contrast would naturally indicate very different conclusions as to the proper form of bridge guard against derailed trains. If it be true that on the Canada Southern, or any other road, more than four-fifths of all the derailments occur from broken running gear or parts above it, so that the train is not in condition to stay on the rails even if replaced on them, then it is evident that anything in the form of a replacer is quite superfluous four times out of five, and that the one thing to do is to treat the derailed trains as presumedly mere masses of wreckage, and simply provide guides for them past the points of greatest danger, to merely keep the wreckage from straying further from the straight and narrow way. This is what the Jordan bridge guard essays to do, and we have no doubt does do as effectually as any appliance can.

DERAILMENTS ON THE CANADA SOUTHERN DIVISION OF THE MICHIGAN CENTRAL R. R. FOR SIX YEARS PAST, WITH CAUSES AND EFFECTS.

Date.	Nearest station.	Cause.	Damage done.
1884.			
March 1	Springfield	Broken truck frame	Trucks smashed.
March 11	East Cornell	Broken rail	Sleeping car off and tipped over.
March 18	Waterford	Train breaking in two	Car off, truck broken.
April 21	Hawtry	Car mounted frog	Wheel off for 1½ miles.
May 30	Rodney	Broken rail	Car off, trucks broken.
Sept. 16	Buxton	Broken axle	Trucks smashed.
Oct. 21	Tilsonburg	Brake beam down	2 cars off, slight damage.
Nov. 20	Marshville	Brake beam down	Trucks smashed.
Dec. 2	Cornell-Hawtry	Truck breaking	5 miles off track, trucks smashed.
1885.			
Jan. 7	Tilbury	Wheel caught in frog	Car off, no damage.
Feb. 3	Brownsville	Broken flange of engine	Engine off track, truck broken.
Feb. 4	Waterford	Jar of train, latch out of Sw. stand	No damage.
Feb. 6	Tilsonburg	Broken wheel	1 pair trucks broken.
Feb. 6	Taylor	Loose wheel	2 cars off, trucks broken.
Feb. 7	Springfield	Broken flange, coach 620	Wheel broken.
Feb. 9	Comber	Loose wheel	Trucks broken.
Feb. 14	Moorhead Bridge	Broken wheel	Bridge broken, 13 cars through.
Feb. 14	Hagersville	Broken wheel	Car off, trucks broken.
Feb. 16	Essex Centre	Loose wheel dining car	Car ran ¾ mile off track.
Feb. 18	Tilsonburg	Broken trucks	Trucks smashed.
Feb. 18	Iona	Broken axle, engine tender	Tender off ½ mile, trucks smashed.
Feb. 20	Deans	Broken car wheel	Car ran 2 miles off track and on at farm crossing.
Feb. 21	Dufferin	Broken car wheel	Trucks smashed.
Feb. 21	Welland	Broken car wheel	Car run 5 miles off track, trucks smashed.
March 1	Dutton	Broken axle	Trucks smashed.
March 19	Buxton	Broken axle	Trucks smashed.
March 23	Townsend	Broken tender axle	Trucks broken.
March 24	Wordslee	Broken rail	Car off 2 miles and on at crossing.
March 25	Yarmouth	Broken car axle	Trucks smashed.
March 30	Perry	Broken rail	Car off, trucks broken.
April 23	Tilsonburg	Brake beam down	Car off 200 ft., no damage.
1886.			
Jan. 28	Kingsmill	Broken car axle	Car off 2 miles, trucks broken.
Jan. 27	Yarmouth	Broken car axle	Trucks broken.
Jan. 26	Shedden	Broken bolt in tender frame	Tender off 1½ miles, trucks broken.
Jan. 30	Yarmouth	Broken car wheel	7 cars off, trucks smashed.
Jan. 31	Montrose	Broken car wheel	Trucks smashed.
Mar. 6	Iona	Broken journal on eng	Engine run ¼-mile off track, trucks broken.
May 19	Canfield	Striking cattle on ×'ing	9 cars off, trucks smashed.
June 13	Shedden	Broken car wheel	Car run 4½ miles off track, trucks broken.
July 8	Muirkirk	Broken car wheel	Car run 1 mile off track, trucks broken.
Oct. 29	Maidstone	Broken car journal	14 cars off, trucks broken.
Dec. 13	Marshville	Broken car axle	6 cars off ¼ mile, trucks smashed.
1887.			
Jan. 3	Attercliff	Broken car journal	Trucks broken.
Jan. 18	Maidstone	Broken axle	Trucks broken.
Feb. 1	Montrose Bridge	Loose wheel	Car run 1 mile off track, trucks broken.
Aug. 18	Shedden-Iona	Broken car journal	Trucks broken.
Aug. 16	Attercliff	Journal burned off	Trucks broken.
Sept. 21	Waterford	Brake beam down	5 cars off, trucks broken.
Oct. 26	Shedden	Train breaking in 3 parts	2 cars off, 1 truck smashed.
Nov. 19	Villa Nova	Bolt out of main con	Car off, not damaged.
Dec. 25	Brownsville	Broken axle	2 cars off, trucks smashed.
Dec. 25	Hawtry-Waterford	Jumping off and on at ×'ing	Car off 80 ft., no damage.
1888.			
Jan. 25	Springfield	Catching ×'ing planks	Sleeper trucks off (1 pr. trucks).
Feb. 12	Taylor	Eng. side rod breaking	Eng. truck off.
Feb. 12	Aylmer	Dining car in frog	1 truck off at full speed, no damage.
March 7	Maidstone	Brake beam down	1 car truck off 1¼ miles, broken.
July 20	Windham	Brake beam down	5 cars off, trucks smashed.
Dec 6	E. Wellandport	Broken wheel	5 cars off for 540 feet.
1889.			
March 4	Essex Centre	Brake beam down	1 car off for 180 ft., trucks broken.
Aug. 18	Tilbury	Broken axle	2 cars off, trucks smashed.
Sept. 6	Hagersville	Broken trucks	1 car off ¾ mile, trucks broken.
Sept. 14	Tilsonburg	Brake beam down	1 car off ¾ mile, trucks broken.
Nov. 9	Canfield	Broken journal	1 car off, 1¼ miles, trucks smashed.
Nov. 17	Stevensville	Misplaced switch	Eng. and 13 cars off track in ditch.
1890.			
Jan. 25	Maidstone	Draw head pulled out	1 car off, trucks broken.
Feb. 13	Windsor, Yd	Broken journal	2 cars off, trucks smashed.

SUMMARY.

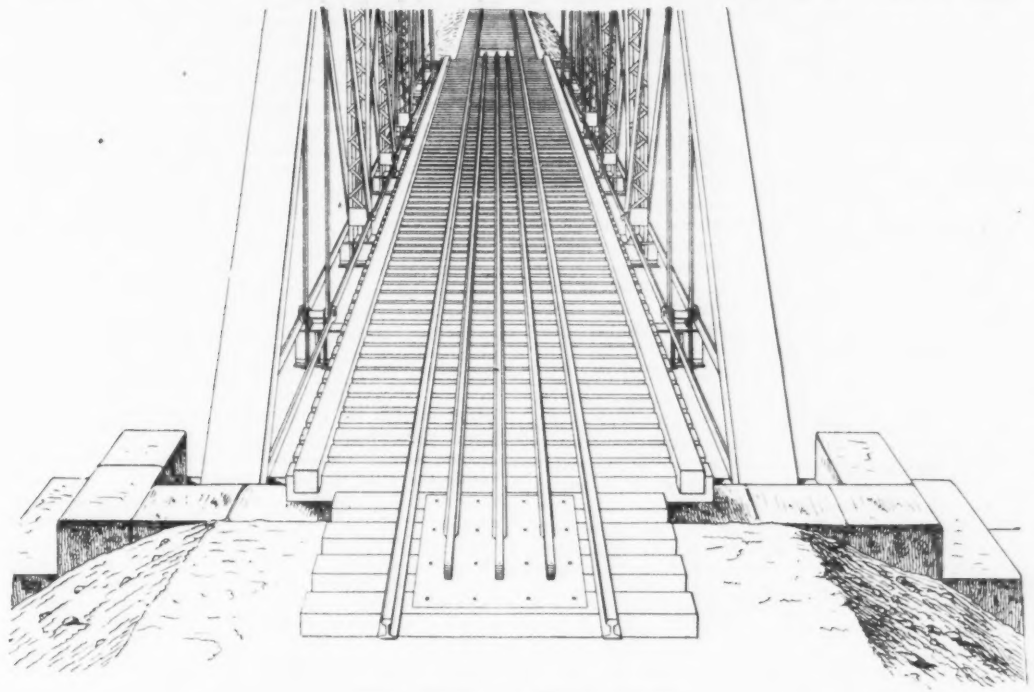
From March 1, 1884, to Feb. 13, 1890, there were 66 derailments.

51 of the 66 cases were broken trucks.
15 " " " " the trucks were not broken.
47 derailments began from some truck failure.
(12 of axles, 6 of axle journals, 10 broken wheels, 4 loose wheels, 1 broken flange, 6 broken frames, etc., 8 brake beams down).
3 came from draw gear failures.
6 from frogs and switches.
3 from engine breakages.
4 from broken rails.
1 from broken driver flange.
2 from accidental obstruction.

Derailed cars ran 180 ft. in 1 instance.
" " " 200 " " 1 "
" " " 540 " " 1 "
" " " ¼ mile " 2 "
" " " ½ " " 1 "
" " " ¾ " " 3 "
" " " 1 " " 2 "
" " " 1¼ " " 3 "
" " " 1½ " " 1 "
" " " 2 " " 3 "
" " " 4½ " " 1 "
" " " 5 " " 2 "

In 21 instances derailed trucks ran considerable distances and in 18 instances ¼ mile to 5 miles, against 45 instances in which the derailed wheels ran but a short or unrecorded distance.

But *if*, on the other hand, the real fact be that in average experience there is less than one derailment out of eight (12 per cent.), in which there is anything whatever the matter with the cars or running gear, then it is obvious that seven times out of eight a bridge guard of the Jordan type will fail of accomplishing the ultimate possible with a bridge guard, which is to replace uninjured cars on the track; but with this in its favor, even then, that it may keep things from going from bad to worse with more certainty than any re-railing device can until the bridge is passed; but, with this in turn against it, that it does nothing to guard against further wreckage beyond the bridge, unless the train be stopped in the meantime.



THE JORDAN BRIDGE GUARD.
Perspective View.

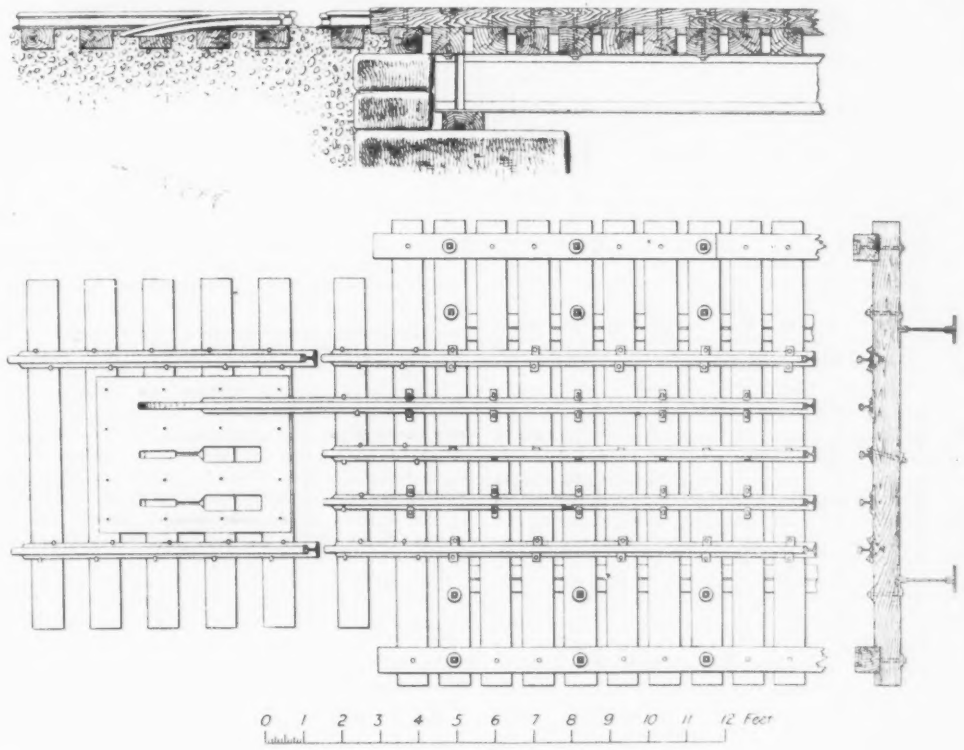
On which side does the balance of advantage lean? We leave every one to weigh the pros and cons for himself, having no prejudice against either view, as we said before, but deeming it essential to point out that the reported percentages of car breakages in cases of derailment on the C. S. Ry. is far greater than the general average, and so possibly misleading.

In a letter accompanying the drawings which we reproduce Mr. JORDAN says:

> It is not an essential feature of my bridge guard to make bridge floors narrow. The Michigan Central make all deck bridge floors 16 ft. wide; this is ample room to prevent cars that are gauge off from tipping off the bridge. My experience is that a single freight car truck off the track will not get gauge off unless there is something to guide it over, but it will pass the center line of track from 2 to 6 ins., and there drag diagonally along the track until the train is stopped or wrecked. A truck when dragging along in this shape is careened so that there is very little or no bearing on the outside wheels, and it is liable to drag along for miles when the track is frozen enough to prevent the ties from bunching; the further it gets off gauge the more careened it becomes. Such derailed trucks work over diagonally and just as far off gauge as the car ahead and behind will allow. The difference in the distance is governed by the length of the link, and by the side play in draw bars. When more cars than one are off together, they will work gauge off and tip over unless there is something to prevent them. Enclosed I send you a statement [herewith reproduced] of derailed cars in a moving train on the Canada Southern division for the past six years, the causes, place, etc., which I think will be of interest to you.

The construction of the guard is so plainly shown in the engravings as to need little description. It consists simply of three equidistant parallel rails between the main rails, the guard rails being bent down at the ends and passed into and under an end plate of boiler iron in such manner that no dragging or broken part can possibly engage with it. Thus, however badly broken the car, the guards form skidways on which the car or engine slides, if it will not roll. All the rails except the center ones are fastened down with Bush interlocking bolts on alternate ties. The central rail is bolted down in each tie. The ties will be seen to be spaced very closely, 3 ins.

The efficiency of the guard was well illustrated in an accident on Jan. 6, 1890, where a train ran into the rear of another one standing on a bridge 600 ft. long and 50 ft. high above the stream. Ten cars were knocked off the bridge or wrecked, the engine moving 513 ft. after the first collision and being piled high with wreckage when it stopped, but the five parallel rails prevented either the pilot of the engine or any of the wreckage in front of it from being forced down under the wheels, and it remained on the track, as did also most of the cars of both trains.



THE JORDAN BRIDGE GUARD.
Plan and Sections.

For an emergency like this no type of bridge guard could be so well adapted as this; and it will be observed also that it is not necessarily antagonistic to the use of re-railing frogs. These may be combined with it if desired. Few may desire to use both; the man who uses either is pardonable; the man who uses neither is, in our deliberate judgment, criminally negligent.

The Efficiency of Locomotives.*

DISTRIBUTION OF STEAM.

Ever since Mr. D. K. CLARK, by his masterly series of experiments 40 years ago, demonstrated the existence of cylinder condensation, the object of by far the greater number of improvements which have been made in steam engines has been to improve the distribution of steam in the cylinders, and to mitigate the losses arising from liquefaction during the earlier stages of expansion and re-evaporation during the later. Objections against the shifting link valve-gear, invented by HOWE, but commonly known as STEPHENSON'S, have been raised so often and urged so persistently, that many appear to take for granted that it is a wasteful and inefficient device. While it undoubtedly has faults, whose existence it would be absurd to deny, its many advantages would seem to be a sufficient guarantee of future use as extended as its past. The two principal charges against it are (*a*) the slow opening of the ports for steam admission, causing wire-drawing and loss of pressure, and (*b*) the early closing of the exhaust, creating an undue amount of compression.

A perfectly horizontal admission line and a sharply defined point of cut-off on an indicator card are, of course, desirable, but a considerable deviation from them is possible before a really appreciable reduction of the mean effective pressure takes place. The excellent means of balancing slide-valves now in use, unpatented and free to all, permit ports of large area to be employed, while the supplementary port of the Allen or Trick valve is a valuable aid in overcoming the fault of wire-drawing. It is, therefore, no exaggeration to say in 1890, as Mr. CLARK did in 1852, that with a well-designed link motion of liberal proportions the objection of wire-drawing is of no practical weight. With regard to compression, there is no doubt that at times it does become excessive, considerably more than is necessary for the smooth running of the engine. Even if we did not have the evidence of the indicator as to this, substantial proof is afforded by the fact that the main crank-pins of high-speed locomotives are usually worn more on the sides than on the top and bottom, the pin being on the center when calipered.

CYLINDER CLEARANCE SPACES.

The clearance spaces in any cylinder bear such a close relationship to the compression curve that they must enter into all discussions of it. In engines like the locomotive, where a single valve controls all the events of the stroke, it is undesirable to reduce the clearance spaces to less than 7 or 8% of the piston displacement, for at short points of cut-off the compression line would run up so abruptly as to reach initial pressure before the piston had reached the end of the stroke. From one point of view, the steam of compression should reach a pressure just sufficient to arrest the motion of the piston, crosshead, etc. Any increase above this detracts unnecessarily from the area of the indicator card, but does not diminish the efficiency of the engine. On the other hand if compression is carried to initial pressure, none of the incoming steam

*A paper by W. F. DIXON, Paterson, N. J., read at the Cincinnati meeting of the American Society of Mechanical Engineers.

is required to fill the clearance spaces and to raise the cylinder walls to a temperature as high as its own. This is indubitably the reason why the locomotive engine at high speeds and short cut-offs is as economical a machine as it is. The reduction of indicator card area caused by early exhaust closure and the large clearance spaces found in locomotive cylinders, is often overestimated.

If compression takes place suddenly, as is the case in cylinders having very small clearances, the heat does not have time to become equalized between the steam and the cylinder walls, and the power required for compression will be in excess of that necessary were the action to take place more gradually.

From the foregoing the writer has been led to the conclusion that although the clearance spaces in locomotive cylinders are usually larger than desirable, there is a limit, pretty sharply defined, below which it is prejudicial to go in reducing them, provided the link motion is retained.

In cases where excessive compression has been found to limit the power of high-speed locomotives, a little inside clearance to the valves has been of great benefit in reducing it. This remedy might be advantageously used far oftener than it is, and would materially lessen the force of the objections erroneously urged against the link motion.

CYLINDER CONDENSATION AND RE-EVAPORATION.

To overcome these evils steam-jacketing, superheating and compounding have been suggested and tried.

That steam-jacketing the cylinders of a locomotive taken by itself and not in connection with compounding, would result in some little saving may be taken as certain, provided sufficient means of draining were used. The application of jackets to the cylinders of an ordinary locomotive by Mr. BORODIN, of Kief, Russia, showed a mean economy of steam about 13%. This, however, is probably much greater than could be expected in regular day-in, day-out service; and it is still further probable that the expense of constructing and maintaining the jackets would more than neutralize the benefit derived.

Superheating the boiler steam, to the degree of increasing its pressure, before admitting it to the cylinders has been tried several times in locomotive practice, and as often abandoned. The chief difficulties met with were: (a) The expense of providing and keeping up the superheating apparatus; (b) the difficulty of lubrication, owing to the vaporization of the lubricants at the high temperature; (c) the impossibility of preventing leakage at the stuffing boxes, all vegetable packings charring with the heat and becoming worthless. Nor is it likely that the metallic packings, now so largely used, would be able to overcome this last difficulty, for, with a possible exception or two, their prominent features are steel springs and white metal rings. The springs would gradually lose their temper and become useless, while the soft rings, fusible at temperatures of from 250° to 400° F. would melt.

The Chicago, Burlington & Quincy Railroad Co., between the years 1870 and 1874, went fully into the subject of superheating. In these experiments the front tube sheet of the engine was set back into the barrel of the boiler some distance from its normal position. In the space thus left was fitted a separate cylinder, filled with tubes through which the products of combustion had to pass on their way to the atmosphere. The dry pipe entered this cylinder at the top, and the steam, after circulating among the tubes, and becoming superheated in doing so, passed to the cylinders of the engine through pipes connected to the bottom of the superheater. The resulting economy was, however, more than offset by the expense of keeping up.

COMPOUNDING LOCOMOTIVES.

The advantages claimed for compounding are two in number. First, economy in the use of steam and, consequently, fuel; and, secondly, a more uniform pressure on the cranks. The latter, although largely incidental, is held by some engineers, rightly or wrongly, to be the greater of the two, as a more uniform crank-pressure, followed to a logical conclusion, means greater durability of parts, and a possible lengthening of the life of tires, caused by the reduction of wheel-slipping.

It is tolerably certain, though, that were this to begin and end the advantages derivable from compounding, the continuance in favor of the ordinary single expansion engine, to the exclusion of the compound, would be assured. The economy shown by the compound locomotive is usually attributed to the lessening of cylinder condensation, due to reducing the range of temperature per cylinder. When engines with well-protected cylinders are running at high speeds, it is hard to understand how condensation can take place to any hurtful extent. The writer has examined a large number of cards taken from locomotives at speeds ranging from 40 to 65 miles per hour, but has been unable to detect any trace of either condensation or re-evaporation. Supposing, though, that some small amount of steam, say, 7%, was condensed at each stroke, why expanding in two cylinders, one presenting twice the area of the other, should diminish it is almost beyond comprehension. At slow speeds, however, the benefit of compounding is beyond dispute, as witness the success of the system both in marine and stationary work; but the bulk of the compound locomotives so far built have been for express passenger traffic. If, then, the increase of boiler pressure which has almost invariably been introduced with compounding cannot be held accountable for the economy claimed, it would seem that Sir FREDERICK BRAMWELL struck the right key when, in a lecture delivered by him in 1877, he said:

"There is no doubt that the double-cylinder engine is the engine of the present day. I do not think its economy really lies in its principle, but that its economy in practice arises from another thing altogether, and that is this: That by making a double-cylinder engine you put it out of the power of an ignorant engine-driver to do away with that which you want—high expansion. He must get high expansion; he is compelled to use it, whether he likes it or not. Whereas, with the single-cylinder expansive engine, he has the power to follow the dictates of his own ignorance; and, as a matter of observation, I have hardly even seen such an engine left to the control of an engine-driver but it invariably worked at the lowest possible grade; and, as I have said, I believe that this withdrawal of control is to a large extent the secret of the success of the compound cylinder engine."

Locomotive-engine runners are notoriously disinclined to run their engines with a full-open throttle, and to regulate the power of the engine by the valve-gear. But it will not do to make so sweeping an assertion about American runners as Sir FREDERICK BRAMWELL did about the English, for the design of the steam-distributing gear on many locomotives is such that the engines cannot be handled entirely with the reversing lever. When in compounding we get an engine which *must* be worked expansively, irrespective of the shortcomings of the valve-gear it is obvious that good results must follow.

HIGHER BOILER PRESSURE.

Within limits, imposed by practical considerations, increase of boiler, or, more properly, initial pressure adds to the efficiency of the steam. For illustration take the difference in the efficiencies of steam at 140 lbs. and 200 lbs. gauge pressure. The temperature of the former is 361 degrees F., and that of the latter 388 degrees F., a difference of 27 degrees. The extra quantity of fuel required to be burned to bring about this increase of temperature is small, 2%* of the amount required for the generation of the 361 degrees steam being over, rather than under, the mark. The smallness of this percentage is due to the fact that the latent heat of the steam at the two pressures is practically the same; consequently the increments of heat go almost entirely to raising the temperature. If the steam in each case was expanded to 25 lbs. absolute, the efficiency of the 140 lbs. steam (assuming expansion to take place in accordance with Boyle's law, PV = constant), calculated by the well-known formula,

$$E = \frac{T - t}{T},$$

would be

$$\frac{(461 + 361) - (461 + 240.1)}{(461 + 361)} = 14.7\%;$$

and that of the 200 lbs. steam would be

$$\frac{(461 + 388) - (461 + 240.1)}{(461 + 388)} = 17.4\%,$$

an increase of 15.5%.

Correcting for the additional fuel consumed, the actual increase of efficiency would be

$$\frac{100}{102} \times 15.5 = 15.1\%.$$

Increase of pressure, however, necessitates greater strength and weight in the component parts of the boiler.

If the thickness of the plates forming the cylindrical portion of a boiler designed for the lower pressure is $\frac{7}{16}$ in., $\frac{5}{8}$ in. material must be used in constructing a boiler for the higher pressure, provided the same diameter of barrel, the same factor of safety, and the same quality of plate and style of riveting are retained. As, however, the efficiency of 200-lb. steam is greater than that of 140 lbs. pressure, the cubical capacity of the boiler may be reduced somewhat; but as the fire-box must be kept of at least the same dimensions as before, in order to prevent an unduly high rate of combustion per unit of grate area, any saving in this direction would be insignificant. Beside the barrel plates, those of the fire-box, together with all stays, braces, etc., must be increased in proportion.

Supposing the 140-lb. boiler to weigh 18,000 lbs., the other would weigh about 25,000 lbs., or 7,000 more. Estimating the price of a locomotive boiler to be 10 cents per lb., this would add $700 to the cost.

Regarded merely as additional weight to be hauled, this increase, amounting to less than half the weight of an empty box-car, would not at all seriously diminish the gain to be derived from the high pressure steam; but, unfortunately it must be carried, for the most part, by the already heavily loaded driving wheels of the engine.

A gauge pressure of 200 lbs. per sq. in. would seem to be about as high as is desirable to go in efforts to increase the efficiency of the steam. Steel plates, which are now used almost exclusively in locomotive work in this country, become unreliable at a temperature of about 450° and it is, of course, imperative to keep well within the bounds of absolute certainty and safety. Beside this, the objections which obtain in the case of superheated steam, and enumerated further on, apply with equal force to saturated steam of very high tension.

It may be pertinent to say here that there is no difficulty whatever in obtaining steel plates for boiler work thoroughly uniform and reliable. In the shops in which the writer is employed, with the exception of a few copper fire-box boilers built for South America, nothing but steel has been used for this purpose in five years. Steel for stay bolts, on the other hand, is not an unqualified success; and several locomotive men have gone back to iron as being the better material.

* The exact determination of this quantity is impossible for obvious reasons, although the requisite number of heat units is known.

SIX-COUPLED ENGINES.

During the last two or three years, in order to avoid the excessive weight per wheel entailed by large and heavy boilers, several railroad companies, running fast passenger trains, have discarded the "American," the generally accepted type of passenger locomotive, for a six-coupled engine of the "Mogul" or 10-wheeled type. Engines of this kind permit of a large adhesive weight while keeping the static load per wheel within reasonable limits; but, owing to the great weight per foot run of driving-wheel base, are more destructive to bridges—except those of very short span—than their predecessors. With respect to increase of internal resistances caused by adding to the number of driving-wheels, it is the firmly rooted belief of many engineers, notably in England, that a "single" engine, having but one pair of drivers, runs more freely at high speeds than one having two pairs of drivers, and so on, owing to the multiplication of bearings and the consequent increase of friction. Nobody, so far as the writer is aware, has ever produced any evidence, apart from generalities, to prove this; but it may well be, and undoubtedly is, true in cases where the road run over abounds in frequent curves of short radius. On lines having a large percentage of tangents, however, the writer has not been able to notice any appreciable difference in freedom of running between engines of the "American" type and 10-wheelers. Although the use of 6-coupled engines for passenger service has afforded some substantial relief to the overburdened wheels of the 4-coupled machines, the demand for greater power is always present and in some recent instances the driving-wheels of passenger "Moguls" and 10-wheelers carry as heavy a weight as the maintenance-of-way engineers will countenance.

Few locomotive engineers would admit the desirability of running 8-coupled engines of the consolidation or 12-wheeled types at high speeds, owing to the great weight per foot run, and if it is really essential that more power be forthcoming, some radical change in locomotive construction is inevitable.

TRACTION INCREASERS.

It may safely be stated that no locomotive built during the last 20 years has been deficient in adhesive weight after once getting its train well in motion, notwithstanding the slight and unreliable evidence adduced to the contrary. In other words, the mean effective pressure in the cylinders when running at all fast is quite insufficient to cause the tractive force to exceed the adhesion. A feature of any substantial change in locomotive design will then probably be a method of increasing the coefficient of adhesion at starting, for although many devices tending to this end have been experimented with, we still, in default of something better, have to rely on mere dead weight, a large proportion of which is useless at other times, to get the trains away from the stations.

EFFICIENCY OF BOILER AND FURNACE.

The evaporating efficiency of a boiler depends upon the nature of the fuel burned under it, and as anthracite and bituminous coal are, generally speaking, alone used in this country for locomotive work, they may be considered to the exclusion of all other kinds. Recent experiments on the New York, Lake Erie & Western R.R., with high-class modern locomotives, gave evaporating rates, from and at 212° Fahr. per lb. of coal, of 5.68 for anthracite and 7.2 for bituminous. These figures are probably somewhat higher than the average performance of locomotive boilers throughout the country, but represent what is possible and what can be obtained when the firing and handling of the engine are done with reasonable intelligence.

Anthracite, as burned in the fire-boxes of locomotives, is an extravagant fuel, whose use is justified only by cheapness of cost, or by some other qualification which is considered indisdensable—cleanliness, for example.

Much higher evaporative performances than those mentioned are frequently claimed, as much as 10 lbs. of water per pound of coal in some cases; but although such results are, of course, attained in stationary and marine practice, it is extremely doubtful whether, in locomotive work, they are actually reached. Where such figures are arrived at it is safe to assume, unless the evidence against it is overwhelming, that large quantities of water pass over into the cylinders with the steam, while a considerable amount may easily go to waste by way of the safety valves. It is a matter of great difficulty to determine the exact quantity of water fed to a locomotive boiler, as the time allowed for replenishing the tank at way-stations is so short that the swash caused by the rush of water from the stand-pipe does not have a chance to subside before being augmented by the jolting motion of the re-starting train. If sufficient time is allowed for taking an accurate reading, the conditions do not conform strictly to regular service, as the time so lost must be made up

again by increasing the average speed. The operation of a locomotive boiler militates againse a high duty. Its exposure to constantly changing volumes of atmospheric air cannot but be a fruitful source of loss, and the remarkable differences of opinion with regard to boiler proportions, grates, and draught appliances, prove that some boilers, at least, do not have a fair chance to perform their functions in an economical manner.

From the foregoing, the efficiency of a well designed bituminous coal burning boiler may therefore be taken at

$$\frac{7{\cdot}2 \times 100}{12} = 60\%,$$

which, considering the disadvantages under which it labors, is, the writer thinks, a creditable figure.

DISCUSSION.

ANGUS SINCLAIR: The portion of Mr. DIXON'S paper relating to cylinder compression in locomotives, deals with a subject about which considerable misapprehension exists. When an engineer first examines an indicator diagram, taken from a locomotive running fast and cutting off short, he is almost invariably inspired with an ambition to distinguish himself by reforming the locomotive. If he is so placed that the aspirations of theory are unchilled by the demonstrations of experience, he will lose no opportunity to deride the ignorance of the railway engineers who persist in using an engine that produces such a reprehensible card. If the would-be reformer gets the opportunity to arrange the valve motion of a locomotive to accord with his idea of the eternal fitness of that mechanism, the engine will invariably use more coal in doing certain work than one equipped with the much maligned link motion.

Most of those who are struggling to improve the distribution of steam in locomotive cylinders are laboring to popularize a delusion. Because certain phenomena would imply very bad practice in a stationary engine, they argue that their occurrence in a locomotive must prove the performance of the engine to be defective. The two cases are not parallel. The locomotive of to-day is a machine developed to meet the requirements of peculiarly severe and varying service. The proportions of cylinders and other passages do not vary materially among the locomotives of different railroads or of different countries, and these proportions are undoubtedly those that produce the most satisfactory results in the performance of work. In no practical case has it been found best to make the proportions of steam ports approximate to the sizes considered necessary with good stationary engines. When this important feature is so differently proportioned in the two kinds of engines, how can a reasonable man expect that the distribution of steam will be nearly alike?

The comparatively small ports, and the restricted opening at short points of cut-off, make a high compression line absolutely necessary, to enable a lomotive to perform fairly heavy work at high speed. If the compression does not reach close to boiler pressure, the steam line will drop so suddenly that the engine can do very little work when the piston speed is close to 1,000 ft. per minute. Increasing the size of the card by reducing the compression is a plausible theory; but in practice, at very high speed, it leaves the main rod to drag the piston away from the end of the cylinder. In many instances, however, compression is carried to excess, even for the requirements of a high speed locomotive. In such cases, loss of efficiency and of economy result.

I can scarcely agree with Mr. DIXON'S views on steam jacketing. It is by no means certain that steam jacketing has proved successful on any high speed engine, and there are peculiar difficulties in making such a device work well on a locomotive. The application of a steam jacket by Mr. BORODIN, referred to in the paper, proved nothing. The locomotive was experimented with in a shed, with small power, and running at uniform speed. These conditions are very different from the ordinary work of a locomotive. Few engineers would allow themselves to be influenced by results that are not obtained in road service. I have known of several very careful experiments which were made to ascertain the value of steam jacketing on the cylinders of locomotives, and in every instance the jacket was decided to be of no value.

I agree with Mr. DIXON that it is hard to understand how condensation can take place to any hurtful extent when engines with well-protected cylinders are running at high speeds. I feel compelled, however, to admit that such condensation does take place, and to a much greater extent than 7 per cent. of the steam admitted to the cylinders, even though, like Mr. DIXON, I have failed to detect evidence in any high speed cards of condensation or evaporation. There is so much of what HEMINWAY calls "initial expansion" in the cylinders of high speed locomotives that it is impossible to judge how much of the drop is due to condensation or to wire drawing. Nozzles and contracted steam passages exert so much influence on the exhaust end of the card that it is practically impossible to detect the signs of evaporation.

Although the view is taken by such a high authority as Sir FREDERICK BRAMWELL, I attach very little importance to the assertion that a vital element in making the compound locomotive a success is the tergiversation of the ignorant engineer driver, who refuses to work the steam expansively. If compound locomotives prove successful enough to make that engine the railway motive power of the future, that consummation will be produced by the same causes which have made marine and stationary compound engines popular with steam users, viz., the capability of using them to greater advantage.

L. S. RANDOLPH: In regard to the efficiency of locomotive, the question has been and is now, not so much what is the efficiency, but what is the power; not so much how many foot pounds of energy it will develop per 100 pounds of combustible, but how many cars it will haul and make schedule time. Within certain limits, the efficiency of the railroad as a machine for transportation is of more importance than the efficiency of the locomotive. The tests of the efficiency of the locomotive, as usually made, are not only exceedingly difficult, but also unreliable. The varying facts of grades, curves and speed, together with the short time it is possible to give to the test, make it impossible to obtain the accuracy that the subject demands. Not until we take a leaf from marine engineering and make, as it were, "dock trials" of a locomotive, will we get the accuracy and reliability that we should. With the locomotive jacked up, and a Prony brake to measure the power developed, we should be able to get, with accuracy, the efficiency of the locomotive under varying conditions of load, speed, etc., other conditions being kept uniform. Knowing these points accurately, we could determine how much was gained or lost by over-loading or under-loading an engine, as well as the effect of varying dimensions.

W. O. WEBBER: It seems to me the modern locomotive is one of the most maligned pieces of mechanism in existence. I consider it one of the highest types of high-speed engines now running, and it is operated under most unfavorable conditions.

The author speaks of engineers running their engines by the throttle instead of by the reverse lever. It should also be said that engineers are not entirely to blame for this. As locomotives are frequently built the engineer cannot keep his engine at a given speed by the reverse lever alone, but must use the throttle.

GEO. S. STRONG: A locomotive is not a wasteful machine so long as it is not pushed beyond its capacity. The difficulty arises in handling trains requiring 1,000 to 1,200 HP., with locomotives which can only generate economically two-thirds that power. With an engine I propose to put in service I expect to develop a horse power with 18 lbs. of steam, whereas the ordinary engine uses about 27 lbs.

D. L. BARNES: It is fortunate that engine drivers do not run entirely with the reverse lever, particularly with locomotives having a tendency to prime. Before we can get any accurate knowledge of the amount of steam used by locomotives some practical calorimeters for locomotives must be devised. Estimating cylinder condensation from indicator cards is simply impossible. As to compounding, if it is good at slow speeds it is good at high speeds. One excellent point of the paper is its commendation of the principle of traction increasers.

The Mechanical Equivalent of Heat.

The very careful experiments made by Prof. ROWLAND at the Johns Hopkins University for determining the mechanical equivalent of heat do not seem to be as well known here as abroad. In 1878 the late Dr. JOULE made a series of determinations of this unit, which gave an average value of 773.9 ft.-lbs., in place of his original determination of 772 ft.-lbs. These experiments were all made with water at 60° Fahr., and the results then reduced to 39.1° (the temperature of the maximum density of water), by means of REGNAULT'S law of reduction, which depends upon the specific heat of water, as determined by him. Prof. ROWLAND found that this law was not true for any but high temperatures, and his investigations, conducted with a care which has met with the highest admiration from physicists the world over, have fixed the values of the mechanical equivalent of heat in the latitude of Baltimore, as shown in the accompanying table, taken from Prof. WOOD'S "Thermodynamics."

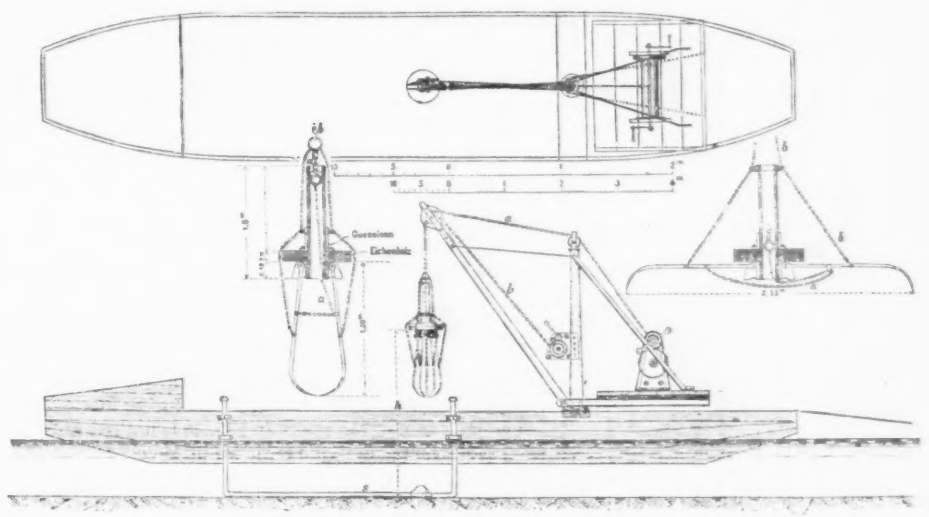
Temp. C.	Temp. Fahr.	Mechanical equivalent. Air thermom.	Mechanical equivalent. Mercurial thermom.
4	39.1	783.4	778.3
5	41	783.0	778.1
6	42.8	782.5	777.9
7	44.6	782.2	777.6
16	60.8	778.4	775.4
27	80.6	775.5	774.4
36	96.8	775.9	774.7

These experiments were made with air thermometers, which are much more accurate than those in which mercury is employed, such as Dr. JOULE used.

Since the specific heat of water, and with it the mechanical equivalent of heat, rises from about 80° Fahr., physicists, who are careful to be precise, now take 778 ft.-lbs. as a fair average value of the latter; although, as we lately said, for rough practical purposes the old unit of 772 still is very largely used, as determined in JOULE'S famous experiments of 1843-50. Tables of the properties of steam, using 778 ft.-lbs. in the calculations, were published in 1888 by John Wiley & Sons, of this city. Prof. ROWLAND'S experiments are described in the *Proceedings of the American Academy of Arts and Sciences for* 1880.

A German Stone Dredge.

A recent number of the *Centralblatt der Bauverwaltung* contains a description of a dredge for removing stones from the bed of a river or channel. The grapple is hung to two chains, which are attached to the drums of two windlasses bolted to the frame of a revolving crane, carried on a scow about 42 ft. long by 8 ft. wide. When the dredge has been brought into the position shown in the lower figure, by means of the principal chain, *a*, the jaws of the grapple are opened, as shown in the figure at the right, by tightening the chain *b*. The grapple is then lowered to the bottom. Then by winding up the chain, *a*, the jaws are closed and the grapple is lifted with its load. A bar, *s*, capable of being fixed at any depth, is used in locating the stones. The scow is attached to a point some distance up stream by a cable and then swung from shore to shore. After a complete swing from one bank to the other the cable is paid out for a distance corresponding to the length of the submerged bar and the scow returns to the first bank. By this means every part of the bottom is passed over and any degree of thoroughness attained. The scow is also useful in removing stones too large for bucket dredges. Two of these dredges, costing about $125 a piece, have given very satisfactory results in Hameln, on the Weser River.



A GERMAN DREDGE FOR REMOVING BOULDERS.

Pile Driving and Ditching Plant, Omaha & St. Louis Railway.

(WITH INSET.)

We are indebted to Mr. A. E. BUCHANAN, Superintendent of the Omaha & St. Louis Ry., for the following interesting details, and the accompanying illustrations of an exceedingly ingenious and novel plant, which has been most successful in practical operation, as shown below, and which combines the functions of a pile driver, derrick, ditcher, scraper, and steam plow, all in simple and easily worked form, and all practically tested. The apparatus is so simple in detail, despite the many different different functions which it well fulfills, that the engraving alone, with the following discription, will make it clear.

Fig. 1 of the accompanying inset shows the pile driver as constructed, and the manner of raising the leads. It also shows the folding of the ladder and of the horizontal braces as the leads are being lowered. The leads lower by gravity, the line passed around the axle being used merely to steady them in their descent. To raise them the two men shown in the cut hold the line taut while the car is moved backward (*i. e.*, to the right in the cut, calling the pile driver the front end), causing the line to wind on the axle, and thus raising the leads into position. Thus the raising is done in a moment, without any manual labor, and by moving the car in either direction, changing the winding of the rope to correspond. It usually takes about 2½ minutes to either lower the leads or raise them into position ready for work.

The following Table 1 gives a detailed statement of the operation of this driver for 46 days, beginning Oct. 22, 1889, and ending Dec. 17, 1889.

TABLE I.

DETAIL STATEMENT OF WORK OF PILE DRIVER FOR 46 DAYS, OMAHA & ST. LOUIS RAILWAY.

Date, 1889.	No. piles driven.	Average depth driven.	Time, with leads in position.	Leads raised or lowered.		Total time at work.
	No.	Ft.	H. M.	No.	Min. lost.	H. M.
Oct. 22	25	12	7.	6	20	7.20
" 23	32	14	7.46	6	18	8.04
" 24	26	14	7.35	8	25	8.
" 25	27	15	8.10	6	20	8.30
" 26	32	14	7.42	6	18	8.
" 28	29	14	7.50	8	25	8.15
" 29	26	15	7.10	6	20	7.30
" 31	33	15	8.14	6	18	8.32
Nov. 2	32	14	7.20	8	24	7.44
" 4	33	15	6.10	8	17	6.27
" 5	37	16	8.20	8	27	8.47
" 6	28	16	5.20	6	20	5.40
" 7	30	14	5.46	8	27	6.13
" 8	25	15	4.23	8	20	4.43
" 9	26	15	6.08	10	25	6.33
" 11	13	15	5.10	6	13	5.23
" 12	16	14	5.28	6	18	5.46
" 13	18	14	3.40	6	15	3.55
" 14	22	15	7.08	6	17	7.25
" 15	19	15	7.15	6	12	7.27
" 16	34	12	6.35	6	15	6.50
" 18	34	12	6.36	8	12	6.42
" 19	13	12	3.40	8	10	3.50
" 20	22	12	6.15	10	22	6.37
" 21	26	15	6.30	8	12	6.42
" 22	17	15	6.20	8	15	6.35
" 23	11	15	6.15	8	16	6.31
" 25	13	15	5.40	6	14	5.54
" 26	21	15	5.17	8	22	5.39
" 27	24	15	5.27	10	24	5.51
" 29	28	15	6.25	12	30	6.55
" 30	34	15	6.57	8	27	7.24
Dec. 2	42	18	7.55	6	15	8.10
" 3	21	16	4.44	6	15	4.59
" 4	36	13	7.	4	9	7.09
" 5	37	12	7.55	8	21	8.16
" 25	46	10	6.15	10	18	6.33
" 7	25	16	6.55	10	19	7.14
" 9	45	14	7.32	6	14	7.46
" 10	26	16	5.40	8	18	5.58
" 11	33	16	7.42	8	19	8.01
" 12	28	13	7.05	8	17	7.22
" 13	21	13	5.30	8	17	5.47
" 14	32	14	6.05	10	20	6.25
" 16	35	12	8.20	8	18	8.38
" 17	34	12	7.45	6	14	7.59
Total, 46	1,267	14	301.49	344	14.12	316.01

Number of days worked	46
Average time worked per day	6 h. 52 min.
Average time required to drive one pile	14.965 min.
Average time required to either raise or lower leads	2.477 min.
Length of piles from 14 to 52 ft.; average length 24 ft.; driven	14 ft.
Average cost per foot for piles	15c.
Expenses for 46 days labor $1,683.72	
Expenses for fuel and supplies 262 28	
	$1,946 00
Average cost of a pile in place	$5.14
Trestles driven	41
Average length of trestle	101 ft.

Fig. 2 shows a pile driver similar to that shown in Fig. 1 (but not the same one) fully lowered, and also in advance of it, a special driver carried on the "protection car," which always leads the main driver. This special pile driver, when used, is operated by passing a rope from the hoisting engine on the main driver, and is for cases where the main pile driver is too large or too heavy. It revolves on a pivot over the center of the truck. The main pile driver also swings on a pivot, of course, although Fig. 1 shows it blocked. The special driver is used to drive piles in truss bridges, to lower and drive piles in dry gulches, or to drive foundations for water tanks or buildings near the track, taking, in such a case, power from the engine on main driver. The derrick attachment, shown in place in Fig. 2, is for loading material left over after renewing a bridge or trestle.

The special driver and derrick attachment cost $110.

Fig. 3 shows ditching attachment to the main pile driver. This application was devised by Mr. Buchanan in order to utilize the plant when not wanted for pile driving.

The ditching attachment shown cost $189, and consists of a horizontal shaft 20 ft. long and 4 ins. in diameter, with a center drum 30 ins. in diameter. The two drums at the ends of the shaft are 8 ins. in diameter. The shaft revolves in bearings set on top of the posts as shown in Fig. 3. The caps of the bearings are hinged to the posts, so as to be readily opened to allow the shaft to be turned parallel to the track when not in use, as shown in Fig. 2. The draft beams and suspended platforms complete the ditching attachment, except the shovels, which are of steel, 42 ins. wide × 47 ins. in length and 22 ins. in depth. When filled and hoisted, the earth usually projects about 4 ins. beyond the mouths of the shovels, and is usually from 6 to 12 ins. above the sides. From frequent measurements of ditches excavated it is found that the shovels take a small fraction over a yard each at a filling.

A foreman and four laborers handle the shovels. They are dumped while the train is in motion, as follows:

By reference to Fig. 3 it will be seen that the hoisting rope for each shovel winds on the drum in an opposite direction from the "tipper" rope; *i. e.*, the rope around the handle of the shovel, with its end in the hands of the men. To dump the shovels the hoisting engineer lets go the friction drum, and the engineer on the locomotive applies his brakes at the same instant. The shovels drop, and are caught in their descent by the tipping rope, which is being wound up while the twisting rope is unwinding, because of winding in an opposite direction on the shaft. So it can readily be seen from Fig. 3 that advantage is taken of the weight of the earth in the shovels in avertical direction and also in a horizontal direction, both movements occurring at the same instant that the shovels are tipped, causing them to dump at once even the most adhesive material in almost every instance.

In further explanation it should be noted that the rope passing through the block above the main drum of the shaft, in Fig. 3, is not the hoisting rope from the engine (or it would revolve the drum in the wrong direction), but merely a tackle used for hoisting the shaft out of its bearings, as shown more clearly in Figs. 2, 4 and 6. The actual hoisting as it leaves the drum is on the back side thereof, and is not visible at all in Fig. 3, but may be seen in Figs. 4 and 5.

The center of the shovels when hoisted ready for dumping are 8 ft. from the center of the track. The sides of the shovels, when ready for dumping, stand at an angle of about 30° to the line of the track, making the center of the material as it leaves the shovels about 9 ft. from the center of the track.

The detail statement shown in Table 2 gives an accurate record of the operations of the ditcher for 36 days, beginning April 18 and ending May 30, 1890, and shows better than any words can how efficient a machine it is.

A similar record to that of Table 2 for the first three weeks of the following month of June shows an average of 175 trips per day instead of 162; an average haul of 456 ft. instead of 555; an average day's work of 7 h. 12 m. instead of 7 h. 37½ m.; a time per trip of 2.47 instead of 2.82 minutes, and a cost per yard of 9 cts. instead of 9.4 cts.

The shovels used on the ditcher during the period covered by Table 2, and as shown and described, are not as large as were really desired, but were the largest that could be had at the time. The hoisting engine has two 6x10-in. cylinders, and its hoisting capacity on the shaft is 15,000 lbs.

TABLE No. 2.

STATEMENT OF WORK DONE BY THE OMAHA & ST. LOUIS RY. DITCHING MACHINE FROM APRIL 18 TO MAY 30, 1890.

Date.	Round trips.	Distance hauled.	Time Worked	Average time per trip.
	No.	Ft.	H. M.	Min.
April 18	82	1,100	5 50	4.27
" 19	89	1,170	7 10	4.83
" 21	100	1,900	7 55	4.75
" 22	63	1,580	6 35	6.27
" 23	70	1,340	7 55	6 80
" 24	161	410	8 20	3.12
" 25	167	380	8 35	3.08
" 28	137	700	7 50	3.44
" 29	166	560	8 10	3.00
" 30	176	563	7 55	2.70
May 1	158	960	8 55	3.40
" 2	137	450	7 25	3.25
" 3	192	300	7 30	2.34
" 5	182	360	7 45	2.55
" 6	183	290	8 30	2.80
" 7	190	450	7 55	2.50
" 8	202	420	7 45	2.30
" 9	125	700	6 50	3.28
" 10	151	350	5 35	2.22
" 12	198	460	7 45	2 35
" 13	130	200	4 25	2.00
" 14	205	810	8 55	2.60
" 15	180	520	6 25	2.14
" 16	211	660	9 05	2.58
" 17	215	600	8 50	2.47
" 19	203	200	8 10	2.41
" 20	182	200	8 15	2.72
" 21	205	300	7 50	2.29
" 22	175	1,100	7 30	2.57
" 23	216	330	8 40	2.40
" 24	177	1,000	8 05	2.74
" 26	177	430	7 50	2.65
" 27	221	310	9 20	2.53
" 28	162	350	6 55	2.56
" 29	161	500	7 25	2.76
" 30	89	450	4 40	3.14
Total 36 days.	5,838	555	274 30	2 82

Average trips per day	162
Average cubic yards moved per day, over	324
Average haul in feet	555
Average hours of work per day	7 h. 37½ m.
Average time per round trip	2.82 min.
Average speed of round trip, including stops at ditch	2¼ miles per hour.

Expenses of ditching train for the 36 days covered by the above statement.

1 Engineer	36 days	@	$3.50	$126.00
1 Conductor	36 "	@	3.00	108.00
1 Hoist Eng'r	36 "	@	2.40	86.40
1 Foreman	36 "	@	2.34	84.24
1 Fireman	36 "	@	2.00	72 00
2 Brakemen	72 "	@	2.00	144.00
4 Laborers	84 "	@	1 50 and 60 days @ $1.75	231.00
Coal and supplies				250.18
				$1101.82

Cost per cubic yard $\frac{\$1101.82}{11,676} = 9.4$ cts.

Adding, for wear of machinery, $7 per day, cost per cubic yard becomes 11.6 cts.

It is now being arranged to put on shovels of the following dimensions: Width, 48 ins.; length, 54 ins., and depth, 30 ins., giving about 77 per cent. more capacity, or nearly 2 cu. yds. There is already ample power to handle them. The same number of men can handle them that handle the present ones, and do it in about the same time. At the lowest estimate, this will increase the output 50 per cent. without any increase of expenses. Moreover, it is proposed to put on a second set of shovels 12 ft. or so back of the present pair.

In this case the four laborers would operate both sets of shovels, but it would take about one minute longer to make the round trip than at present, making, on the basis of the past working, about 115 trips in a day of 7 h. 40 m., instead of 162, as at present, but moving at least 7 cu. yds. at a trip and 800 cu. yds. per day, at a cost of, say, $38, allowing in this item $7 for use of machinery. This would make the cost per cubic yard only 4¾ cts. The material that has been handled so far was generally too wet to shovel to advantage in the usual way, and remains in this condition, except a thin crest on top, during the whole working season. We need not say that such material is particularly troublesome to handle by manual labor; yet with the present knowledge of the ditching plant it is expected to readily handle material at 5 cts. per cu. yd., equipped with four shovels.

A further feature to the plant is the plowing attachment shown in Fig. 4, which illustrates the manner of guiding the two hard-pan plows used; plowing being resorted to only when hard-pan is encountered. The two men on the suspended platforms are found to have perfect control of them, even when

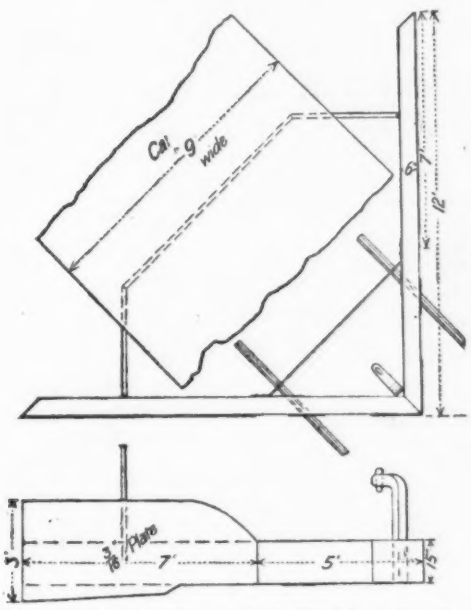
being run on the slope of a cut. This is effected as follows:

A hinged gas pipe, extending from the beam of the plow, passes up through a ring attached to the sliding bar, as shown in the cut. The plow is dragged by the chain, raised or lowered bodily by the hoisting rope, and then guided in detail only by the men.

The wedging plow, shown in Fig. 5, consists of a steel plate 8 ft. × 2½ ft., riveted to two right-angled triangles formed of old rails, the angle at the front being 26°. This plow is reversible, and so can be used on either side of the track. It is used to cut off the foot of the slope, when a cut is not wide enough to admit the ditching shovels at a proper distance from the ends of the ties. It can be turned in at any point on the side of the slope. It is only found necessary to run it through once on each side of such cuts as need widening before the ditch can be made. Its effect is to make a broad bench on the slope, 4 ft. wide, to receive the ditching shovels.

There is also an eye attachment in the center of the face of the plate, so as to give the proper cant for dressing the slopes of the cuts after the ditch has been taken to the proper depth. The draft chain is then attached to the center of the plate. The forward end or point of the wedge is held in position by a chain attached to the beam shown in Fig. 4. The draft chain is of such a length as to permit the plate when moving to assume a position at an angle of 45° to the direction of the track.

Finally, Fig. 6 shows a leveling plow or scraper, used for dressing off the material that has been



Plow for Leveling Dump, as Modified from Fig. 6.

dumped on the embankments from the ditching shoals. When constructed as shown in Fig. 6, it was found to be too narrow at the back end; so it was modified and altered to the form shown in the accompanying small cut. In this form it does its work thoroughly, for in four hours it has leveled off all the material excavated during a month.

Up to about July 1, 1890, 55 miles of the Omaha & St. Louis Ry. had been thoroughly ditched and dressed off by this plant, at a total cost which is very liberally estimated at one-quarter of the cost of doing the work in the usual way. Plants more or less resembling this have been devised from time to time, but this is the most complete and the most successful one that we know of. No other machine, so far as we know, has ever made any such records as those here given. There are no patents on any part of the plant, which will be generally admitted to be strikingly novel and highly creditable to its designer.

Maintenance of Roads.

We condense the following hints from a circular issued by the Roads Improvement Asssociation, of London, England, an organization formed to distribute matter for the education of local highway authorities, road contractors, and others, on the proper construction, maintenance and repair of highways. The actual size of the largest stone allowable for road repair, as recommended by the association, is shown on the accompanying cut.

HINTS TO COUNTRY ROADMEN.

Never allow a hollow, a rut or a puddle to remain on a road, but fill it up at once with *chips* from the stone heap. Always use *chips* for patching, and for all repairs during the summer months. Never put fresh stones on the road if by cross-picking and a thorough use of the rake the surface can be made smooth and kept at the proper strength of section. The rake is the most useful tool in your collection, and it should be kept close at hand the whole year round. Never spread large patches of stone over the whole width of the road, but coat the middle or horse-track first, and, when this has worn in, coat each of the sides in turn. In moderately dry weather, and on hard roads, always pick up the old surface into ridges 6

Largest Stone Allowable for Road Repair (Actual Size.)

ins. apart, and remove all large and projecting stones before applying a new coating. Never spread stones more than one stone deep, but add a second layer when the first has worn in, if one coating be not enough. Use a steel-pronged fork to load the barrows at the stone heap, so that the siftings may be available for "binding" and for summer repairs. Never shoot stones on to the road and crack them where they lie, or a smooth surface will be out of the question. Go over the whole of the new coating every day or two with the rake, and never leave the stones in ridges. Never put a stone upon a road for repairing purposes that will not pass freely in every direction through a 2-in. ring, and remember that still smaller stones should be used for patching and for all slight repairs. Hard stone should be broken to a finer gauge than soft, but the 2-in. gauge is the largest that should be employed under any circumstances. Never be without your ring gauge. It should be to the roadman what the compass is to the mariner; and if you have no ring-gauge, remember MACADAM'S advice that any stone you cannot easily put in your mouth should be broken smaller. Use nothing but *chips* for binding newly laid stones together, and remember that road sweepings, horse droppings, sods of grass, and other rubbish, when used for this purpose, will ruin the best made road.

Water-worn or rounded stones should never be used upon steep grades, or they will fail to bind together.

Never allow dust or mud to lie on the surface of the road, for either of these will double the cost of maintenance. Dust becomes mud at the first shower, and mud forms a wet blanket which will keep a road in a filthy condition for weeks at a time, instead of allowing it to dry in a few hours. See that all sweepings and scrapings are put into heaps and carted away immediately.

The middle of the road should always be a little higher than the sides, so that the rain may run into the side-gutters at once. Never allow the water-tables, gutters and ditches to clog up, but keep them clear the whole year through. Always be upon your road in wet weather, and at once fill up with "chips" any hollows or ruts where the rain may lie. When the main coatings of stone have worn in, go over the whole road, and, gathering together all the loose stones, return them to the stone heap for use in the winter to follow; for loose stones are a source of danger and annoyance, and should never be allowed to lie on any road.

Never allow the grating bars of any gutter or drain to remain parallel with the road, but always set them crosswise, and so avoid serious accidents. No grating, mantrap, water-plug, gas-pipe, or drain should ever be allowed to project above the surface of the road under any circumstances.

Remember that any negligence on your part may cause the ratepayers to lose the benefit of the Government grant—given toward all main roads kept in an efficient state of repair—as well as render your surveyor or overseer liable to an action at law.

The English Canal System.

The *Financial News*, in summarizing a recent report on the English canal system, notes that a few of them still compete very successfully against railways. The Weaver Navigation, the property of the county of Chester, is navigable by steam barges carrying 350 tons of cargo, and "beats the Northwestern out of the field" in the trade of about 1,000,000 tons per annum from the Cheshire salt works to Runcorn or Liverpool, and it returns "a not inconsiderable revenue" to the county. The Aire & Calder Canal, which accommodates vessels of 250 tons, runs from Leeds and Wakefield to the Humber at Goole. Its traffic is carried on by trains of steam-towed barges with an aggregate capacity of some 800 or 900 tons. The proprietors' dividends are supposed to amount to something like 50 or 60 per cent. It competes with the Lancashire & Yorkshire and the North-Eastern Railways. The old Bridgewater Canal was paying well enough to be acquired by the Manchester Ship Canal Co. at a price equal to twice its nominal capital. It carries from Manchester to Liverpool a greater tonnage than is carried by any one of the three rival railway lines, and in fine goods in particular, a remarkable fact, its pre-eminence is yet more decisive. It receives the goods one evening at Manchester, and delivers them next morning, without breaking bulk, alongside the ship in the Liverpool docks.

But the remaining canals which make up the bulk of the three thousand and odd miles of the English canal system are said to be in a sad condition.

Between London and Liverpool there are three canal routes. The shortest of them is 245 miles in length, not greatly longer than the rail routes; but this route is made up of the canals of nine different companies. A boat, 80 ft. long and drawing 4½ ft. of water, could leave London with a load of 80 tons; but at Cowley, 22 miles from London, the cargo would need to be lightened to 65 tons, and at Braunston, some 90 miles further, it would have to be shifted bodily into fresh barges with a carrying capacity of only 25 tons. After another 100 miles, the cargo would need to be transferred once more to larger barges, as the small, narrow boats which alone can pass through the Oxford & Warwick and Staffordshire Canals would not be safe in the open waters of the Mersey. Naturally there is little of this traffic, and there are worse instances than this. Chesterfield, for instance, in the heart of one of the greatest coal districts in the country, is nominally served by a canal connecting it with the Trent; but for nearly two miles this canal runs through a tunnel whose width is only 8 ft. 10 ins., and whose height above water level is only 4 ft. 10 ins., the traffic being worked through by "legging," men lying on their backs and pressing with their feet against the tunnel roof. The Standedge tunnel, over three miles long, is of this size, and worked in this way.

As to rates, the *Financial News* makes this astonishing declaration; translating pence into cents:

> On the point of through rates and booking facilities, it is not easy to obtain much accurate information; but it may broadly be said that, if any man were venturesome enough to attempt to barge goods, say, from Liverpool to London, the only thing he could do would be to give the bargee a purse of sovereigns, and leave him to settle with the nine different companies to be met with *en route;* and that, when the account was rendered, he would find that at one point he was charged 22½ cts. per ton for 6¾ miles, then 13 cts. for the next 37½ miles, and next 33 cts. for 101 miles. Conceive what the trade of the English railways would be to-day under like conditions.

The aggregate of these charges is 68½ cts. for 145¼ miles, or nearly half a cent per ton per mile, which is well up toward the average charge of our railways for coarse freights, and far below those which prevail here under sharp competition.

The following are the principal comparative figures of the existing British canal system:

Independent canals.	Length, miles.	Gross revenue.	Expenditure.	Net profit.
England	2,025	£1,439,343	£861,068	£578,275
Scotland	69	12,011	16,086	*4,075
Ireland	513	89,369	71,541	17,828
Total	2,607	£1,540,723	£948,695	£592,028
Railway Co. canals.				
England	1,024	£437,080	£335,503	£101,577
Scotland	84	57,178	26,599	30,579
Ireland	96	6,495	4,456	2,039
Total	1,204	£500,753	£366,558	£134,195
Grand total	3,811	2,041,476	1,315,253	726,223

*Loss.

The Thames River Draw Bridge at New London.

The accompanying cut gives a view looking through the draw span of the Thames River bridge at New London, Conn. This bridge was designed by Mr. A. P. BOLLER, M. Am. Soc. C. E., who is preparing a detailed account of the structure. The principal features, chiefly summarized from our previous descriptions, are as follows:

The bridge, which carries two tracks, is 1,423 ft. long. It consists of a swing draw of 503 ft., two through spans of 310 ft., and two deck spans of 150 ft.; the clear distance between trusses is 26 ft.; the central height of fixed through spans is 45 ft., and their end height 25 ft.; the central height of the draw span is 71 ft., and its end height 25 feet; the clearance above mean high water, 30 ft.: weight of superstructure, 2,400 tons; masonry, 8,500 cu. yds.; total weight of draw, 1,300 tons. The depth of hard bottom below mean high water varies from 110 to 130 ft. The bridge is proportioned for a moving load of two 86-ton consolidated locomotives, followed by a train load of 3,000 lbs. per ft. on each track.

THAMES RIVER BRIDGE.—A. P. BOLLER, CHIEF ENGINEER.
Looking Through the Draw Span.

Arch Truss.

BY. F. GILMAN, LOWELL, MASS.

The writers on this class of trusses usually restrict themselves to the parabolic or circular form; and I have nowhere seen any complete set of formulas that would apply to the case where the upper chord of the truss had any curvature whatever. In this general case the formulas for giving strains on certain of the truss members are necessarily complex; but it is believed that by representing these complex terms by numerical coefficients, and showing the law of their formation, the expressions for the strains will be comparatively simple. The formulas are given without demonstration, as they can readily be verified by a numerical example, and besides engineers do not usually care for long-winded demonstrations, but desire to have the results of those demonstrations stated in a clear and concise manner, and presented in a form that will be most readily available for practical application.

The following notation will be observed:

Let N denote the number of panels in the truss.
Let P_n " nth lower panel reckoned from the left.
Let F_n denote the nth upper, or curved, chord piece.
Let V denote the longest vertical post, or maximum distance between upper and lower chords.
V_n will denote the nth vertical piece.
w' " " dead load at each lower node.
w'' " " live " " "
$w = w' + w''$
$w''' = \frac{w''}{N}$
h = length of each panel of lower chord.
D_n = nth diagonal which leans toward the left.
s, prefixed to a member, will denote the stress on that member.
The sign + will denote compression.
" — " tension.
n is used to denote the number of any piece whose stress is to be determined, and is always reckoned from the left.

$$s\,F_n = + \left(N - n\right) \frac{w\,n\,F_n}{2\,V_n}$$

$$s\,P_n = - \left(N + 1 - n\right) \frac{(n-1)\,wh}{2\,V_{n-1}}$$

$$s\,V_n = - w\left(a\,\frac{V_{n-1}}{V_n} + b\right)$$

This last formula gives the maximum tensile stress on the nth vertical piece in terms of w, the nth and $n-1$th verticals, and the coefficient a and b, whose values, corresponding to different values of N and n, are given in the following table:

N	$n=2$ a	b	3 a	b	4 a	b	5 a	b	6 a	b	7 a	b
7	— 5	+ 4	- 6	+ 6								
8	— 6	+ 4½	- 7½	+ 7	- 8	+ 8½						
9	— 7	+ 5	- 9	+ 8	-10	+ 10	-10	+ 11				
10	— 8	+ 5½	-10½	+ 9	-12	+ 11½	-12½	+ 13	-12	+ 13½		
11	— 9	+ 6	-12	+ 10	-14	+ 13	-15	+ 15	-15	+ 16	-14	+ 16
12	—10	+ 6½	-13½	+ 11	-16	+ 14½	-17½	+ 17	-18	+ 18½	-17½	+ 19
13	—11	+ 7	-15	+ 12	-18	+ 16	-20	+ 19	-21	+ 21	-21	+ 22
14	—12	+ 7½	-16½	+ 13	-20	+ 17½	-22½	+ 21	-24	+ 23½	-24½	+ 25

It will be noticed that these coefficients follow a regular law when taken horizontally, vertically, or diagonally; and by this means the table can readily be extended to trusses of any number of panels.

The formula for $s\,V_n$ does not apply when $n = 1$; but in this case the maximum tensile stress is always $-w$. The expression for $s\,P_n$ also fails when $n = 1$, but the value for this case is the same as when $n = 2$.

But the vertical pieces, or posts, are exposed to compressive as well as tensile stress, its maximum value being as follows:

$$s\,V_n = + (c\,w''' - a\,w')\,\frac{V_{n-1}}{V_n} + d\,w''' - b\,w'$$

The values of a and b are the same as those given

in the preceding table, while c and d are given in the table below.

N	$n=2$ c	d	3 c	d	4 c	d	5 c	d	6 c	d	7 c	d
7	+20	-10	+18	-12								
8	+30	-15	+30	-20	+24	-18						
9	+42	-21	+45	-30	+40	-30	+30	-24				
10	+56	-28	+63	-42	+60	-45	+50	-40	+36	-30		
11	+72	-36	+84	-56	+84	-63	+75	-60	+60	-50	+42	-36
12	+90	-45	+108	-72	+112	-84	+105	-84	+90	-75	+70	-60
13	+110	-55	+135	-90	+144	-108	+140	-112	+126	-105	+105	-90
14	+132	-66	+165	-110	+180	-135	+180	-144	+168	-140	+147	-126

Considering in this table the vertical rows under c, we find that the successive differences in the first vertical row increase by 2, in the second by 3, in the third by 4, and so on. In the vertical rows under d the successive differences in the first vertical row increase by 1, in the second by 2, etc. In each diagonal row the successive differences are always constant.

The maximum tensile stress on the nth diagonal leaning toward the left is given by the following formula:

$$s\,D_n = -\left(\frac{c'\,w''' + a'\,w' + d'\,w''' + b'\,w'}{V_{n+1}} \cdots \frac{}{V_n}\right) D_n$$

The values of c' a' d' and b' are given below.

N	$n=1$	2	3	4	5	6	7	8	9	10
	c'	c'	c'	c'	c'	c'	c'	c'	c'	c'
7	+ 30	+ 30	+ 24	+ 15	+ 6					
8	+ 42	+ 45	+ 40	+ 30	+ 18	+ 7				
9	+ 56	+ 63	+ 60	+ 50	+ 36	+ 21	+ 8			
10	+ 72	+ 84	+ 84	+ 75	+ 60	+ 42	+ 24	+ 9		
11	+ 90	+ 108	+ 112	+ 105	+ 90	+ 70	+ 48	+ 27	+ 10	
12	+ 110	+ 135	+ 144	+ 140	+ 126	+ 105	+ 80	+ 54	+ 30	+ 11
	d'	d'	d'	d'	d'	d'	d'	d'	d'	d'
7	- 15	- 20	- 18	- 12	- 5					
8	- 21	- 30	- 30	- 24	- 15	- 6				
9	- 28	- 42	- 45	- 40	- 30	- 18	- 7			
10	- 36	- 56	- 63	- 60	- 50	- 36	- 21	- 8		
11	- 45	- 72	- 84	- 84	- 75	- 60	- 42	- 24	- 9	
12	- 55	- 90	- 108	- 112	- 105	- 90	- 70	- 48	- 27	- 10

N	1	2	3	4	5	6	7	8	9	10
	a'	a'	a'	a'	a'	a'	a'	a'	a'	a'
7	+ 5	+ 6	+ 6	+ 5	+ 3					
8	+ 6	+ 7½	+ 8	+ 7½	+ 6	+ 3½				
9	+ 7	+ 9	+ 10	+ 10	+ 9	+ 7	+ 4			
10	+ 8	+ 10½	+ 12	+ 12½	+ 12	+ 10½	+ 8	+ 4½		
11	+ 9	+ 12	+ 14	+ 15	+ 15	+ 14	+ 12	+ 9	+ 5	
12	+ 10	+ 13½	+ 16	+ 17½	+ 18	+ 17½	+ 16	+ 13½	+ 10	+ 5½
	b'	b'	b'	b'	b	b'	b'	b'	b'	b'
7	- 3	- 5	- 6	- 6	- 5					
8	- 3½	- 6	- 7½	- 8	- 7½	- 6				
9	- 4	- 7	- 9	- 10	- 10	- 9	- 7			
10	- 4½	- 8	- 10½	- 12	- 12½	- 12	- 10½	- 8		
11	- 5	- 9	- 12	- 14	- 15	- 15	- 14	- 12	- 9	
12	- 5½	- 10	- 13½	- 16	- 17½	- 18	- 17½	- 16	- 13½	- 10

In the vertical, diagonal and horizontal rows these coefficients follow the same law as before described.

It will be noticed, moreover, that a' may be written from a of the preceding table, c' from c, d' from d and b' from b.

For a parabolic truss these formulas reduce to the following:

$$s\,F_n = + \frac{N^2\,F_n\,w}{8\,V}$$

When the number of panels is odd, $N^2 - 1$ must be written for N^2 in this and the following formula:

$$s\,P_n = - \frac{N^2\,w\,h}{8\,V}$$

$s\,V_n = -w$ for maximum tension.

$s\,V_n = +g\,w''' - w'$ for maximum compression under a partial load. The value of the coefficient g is given in the following table, and it is seen to follow a very simple law when taken vertically, horizontally or diagonally.

N	$n=2$	3	4	5	6
7	+ 2	+ 3			
8	+ 2½	+ 4	+ 4½		
9	+ 3	+ 5	+ 6	+ 6	
10	+ 3½	+ 6	+ 7½	+ 8	+ 7½
11	+ 4	+ 7	+ 9	+ 10	+ 10
12	+ 4½	+ 8	+ 10½	+ 12	+ 12½

When the number of panels is even, the greatest tension on any diagonal is

$$s\,D_n = - \frac{N^2\,w'''\,D_n}{8\,V}$$

And when it is odd

$$s\,D_n = - \frac{(N^2-1)\,w'''\,D_n}{8\,V}$$

The general formulas become applicable to trusses with parallel chords by simply making in them $V_{n-1} = V_n =$ constant.

THE PITTSBURG REDUCTION CO. is now turning out aluminum at the rate of 3,000 lbs. per week, with orders ahead for about six months' output. They have new works now under way with 10,000 HP., 800 HP. being that in use in their present works. The market price continues to be $2 per pound, but it is well understood that this price is likely to be largely reduced as the demand increases and the output becomes larger. In the meantime a Chicago genius is reported to have discovered a process by which he can manufacture aluminum at 15 cts. or less per pound, which is quite possible, and that works are to be started to turn out 1,800 lbs. per week at once in "two six-story buildings," which is going just five stories better than the Pittsburg works.

ALUMINUM WIRE is being used for calking steam pipes in New York with good success. A wire of ⅛-in. diameter is used, one turn of aluminum wire being first inserted, followed by four or five turns of a lead wire of slightly larger diameter, these last being calked in the usual manner. It is found that the aluminum does not cut, and is not acted upon by the steam as the lead is, so that joints remain tight much better.

MR. M. SCHILD, of Denver, Col., calls our attention to the fact that our definition of the Swiss title "Oberst" in our issue of July 19 was incorrect. He states that it is a purely military title, equivalent to our Colonel, "and not of the Kentucky variety either." He thinks that Col. LOCHER belongs to the "Génie" branch of the army, equivalent to our Corps of Engineers.

THE LARGEST TELESCOPE LENS yet made is to be soon undertaken by the Clarks of Cambridge. It will be 40 ins. in diameter, and will be used for the telescope to be erected at the University of Southern California. Its completion will require about two years. The largest lens now in existence is 36 ins. in diameter, also built by the Clarks for the Lick Observatory.

THE LONDON TOWER which is to rival the graceful Eiffel tower, of Paris, will probably be erected at Wembley Park, which is 10 minutes by fast train from the Baker St. station of the Metropolitan Ry. (underground). Sir EDWARD WATKIN, the projector of the tower, is also President of the railway company. The tower company has purchased 288 acres of land at the park for a permanent exhibition, and shares for the tower scheme are to be offered to the shareholders of the railway company.

THE OCEAN RECORD has been again beaten by the *Teutonic* in a remarkable race with the *City of New York*, which also beat her own best record nearly five hours, but was beaten by the *Teutonic* nearly three hours, the *Teutonic* having started some 45 minutes later, and arrived 2¼ hours sooner, so that the two vessels were in sight of each other for over five days. The ocean records under 6 days now stand as follows:

	Days.	H.	M.	Dist. Trav.	Speed.
Teutonic	5	19	5	2,806	20.175
City of Paris	5	19	18	2,788	20.01
City of New York	5	22	7	2,791	....
Majestic	5	22	58	....	....

The *Teutonic* consumed some 320 tons of coal per day, and made a day's run of 512 miles against 515 made by the *City of Paris* last season. The *Teutonic* made on her last trip 5d. 21h. 55m., or better than any other boat but the *City of Paris* has ever made.

THE CIGAR-SHAPED STEEL BARGE invented by Capt. ALEX MCDOUGALL, of Duluth, Minn., is proving a great success, which is contrary to the usual experience with innovations in marine architecture. Five of these barges, built at the Duluth yards, are now plying on the great lakes, and a cigar-shaped steel steamer is now building there. Two more barges are under construction at the Erie Basin dry docks, Brooklyn, N. Y., by HANDREN & ROBINS. They are to be used by the Signa Iron Co., of Philadelphia, for transporting iron ore from Cuba. They measure 190 ft. over all, 32 ft. beam and 20 ft. depth. It is stated that a great ship building plant is to be erected on Puget Sound for the building of these barges and other ships and boats. The American Steel Barge Co., of Duluth, owns the patents for these vessels and is putting them into service.

PERSONALS.

WM. R. NORTHWAY has resigned his position as City Engineer of Chicago.

Mr. H. S. HAINES has been appointed General Manager of the Alabama Midland Ry.

Mr. W. J. KNIGHT has resigned his position as President of the Dubuque & Sioux City Ry.

Mr. A. L. HAWLEY has been appointed Division Engineer of the New Mexico Division of the Union Pacific Ry.

Mr. A. L. HORNER has resigned his position as Superintendent of the Tacoma Division of the Northern Pacific R. R.

Mr. J. THOMPSON has been appointed Superintendent of Bridges and Buildings in place of Mr. J. A. FUSTABEND, resigned.

Mr. E. D. LAURIE has been appointed Division Superintendent of the Intercolonial Ry., with headquarters at Stellarton, N. S.

Mr. P. S. BLODGETT has been appointed Superintendent of the Eastern Division of the Lake Shore & Michigan Southern R. R.

Mr. JOHN EWAN has been appointed Superintendent of the Southern Division of the Louisville, New Albany & Chicago Ry., vice MR. LOOMIS, resigned.

Mr. W. H. BRIMSON has been appointed Assistant Superintendent of the Pacific division of the Northern Pacific Ry., with headquarters at Tacoma, Wash.

Mr. G. W. TILTON, Superintendent of Motive Power of the Chicago & Northwestern Ry., was seriously injured in a railway accident on the above line at Chicago, Ill., Aug. 8.

Mr. E. MCNEILL, General Manager of the St. Joseph & Grand Island Division of the Union Pacific Ry. has been appointed to a similar office on the Oregon Ry. & Navigation Co.

Mr. K. E. HILGARD, M. Am. Soc. C. E., formerly Prin. Asst. Eng. in charge of the Fourth St. extension of the Cincinnati Cable Ry., sailed Aug. 13 for Europe, where he will travel for several months.

Mr. A. M. BEAL, formerly Superintendent of the California Division of the Atlantic & Pacific Ry. has been appointed Assistant Superintendent of the Union Pacific Ry., in charge of the Denver station and yards.

Mr. FRANK SNYDER, of Columbus, O., has resigned his position as Engineer in charge of the intercepting sewer now building in that city, and has opened an office for general hydraulic and sanitary engineering.

Mr. N. LAWSON, formerly Superintendent of the Olympia & Chehalis Valley R. R., has been appointed Superintendent of the Port Defiance R. R., succeeding Mr. G. W. BALCH, now with the Tacoma & Lake City R. R.

NEW PUBLICATIONS.

AUGUST MAGAZINES.

The magazines as a whole are singularly dry of technical matters this month, as becomes midsummer numbers. The most striking article is one in the *Popular Science Monthly*, explaining how it has been discovered through the spectroscope that the star Mizar of the Great Bear (the middle one of the three stars which make the handle of the dipper) is not only accompanied by a dim satellite with a period of revolution of about 2,000 years, which has been known for sometime, but is itself a double star, of a kind never heretofore discovered in the heavens, the two nearly equal masses having a velocity of revolution of 100 miles per second, a period of revolution of 104 days and a distance apart of only 143,000,000 miles (about the distance of Mars from the sun) which brings them so close that no telescope can ever hope to make any approach to separating them. From the comparative periods of revolution (104 days against 687 for Mars) it is deduced that the total mass of the two stars is 40 times the mass of the sun. This is a Cambridge, Mass., discovery, but almost simultaneously a like discovery for another star (Algol, in the head of Medusa) was made at Potsdam, the two bodies in this case being one dark, the other bright, less than 3,000,000 miles apart, with a period of revolution of only 68.8 *hours*, the two bodies being each nearly as large as our sun. The article is short, but impressive evidence of scientific progress. "Sanitary work in Great Disasters" is a rather overdrawn account of the successful sanitary precautions at Johnstown, which fortunately is not likely to be soon repeated. An article on the brain indicates that many conclusions by GALL, the first phrenologist, have been recently proved correct.

The *Century* contains an article of great interest on the Yosemite Valley, showing the urgent need for enlarging

the boundaries of the reservation, both to include its water-shed and to include numerous groves of the big trees, of which there are more than most people understand. An article on "The Forgotten Millions" by President ELIOT, of Harvard, describes the simple life of the Mount Desert, Me., natives, where $250 a year, with a house, garden plot and cow-pasture, is enough to bring up a good sized family comfortably, and where also, we may note, we have a hopeful example of a poor town maintaining good roads, of course with a special inducement thereto in the summer visitors.

The *Atlantic* might perhaps with profit drop the "Science" from the "Literature, Science, Art and Politics" to which it claims to be devoted, the nearest approach to scientific matter being Dr. HOLMES' clever poem on "The Broomstick Train; or, The Return of the Witches," which is almost in its best manner, and as the production of a man so nearly verging on four score, and who has been a prolific writer for half a century, is marvelously clear. An article by Professor SHALER on "The Use and Limits of Academic Culture" is worthy of especial note, however, as a thoughtful and broad-minded resumé of the modern educational problem.

Harper's has an exceedingly interesting article on "The Geology of Chicago and Vicinity," by ELLEN B. BASTIN, and with that its strictly technical contents end; but EDWARD EVERETT HALE'S article on "Magellan and the Pacific" tells a vivid story of old adventures and of the difficulties of early navigating methods.

Scribner's is a "fiction number," and necessarily non-scientific, and *Lippincott's* we do not expect much science from. It contained last month, however, an article which we failed to notice at the time on "Keely's Contributions to Science," by Mrs. BLOMFIELD-MOORE (the lady who is so generously supplying him with funds) which we can commend to those who wish to know all about this great mystery. It is an article of some length, written apparently in the frankest spirit, and if there is a word in it from first to last which will convey to any reader an intelligent idea of what the Keely motor is claimed to be, it will do more than it has for us. We may say, however, that various members of the staff of this journal have recently witnessed some formal and informal tests of Mr. KEELY'S, and while the tests were not such as to produce a conviction of any kind in their minds, they deem it but just to say that the circumstances seemed to exclude reasonable suspicion that trickery with electricity or compressed air was at the bottom of the mystery. The mere fact that Mr. Keely's procedures have been critically examined by dozens of people during the last fifteen years without detection of any trickery of this kind, goes far to support this conclusion; but, on the other hand, it is quite certain that Mr. KEELY has accomplished nothing yet of practical value or of definite and comprehensible scientific value. He does do some curious things, which may be described as wonderful, if they are what they purport to be.

The North American Review contains an abstract by the DEAN OF WESTMINSTER of the address delivered by him before the visiting engineers in Westminster Abbey last year, a striking note on "Stanley's Pigmies," the strange little race of dwarfs which STANLEY hit upon in his last perilous journey, and a valuable article on "The Pasteur Treatment," but otherwise is chiefly given up to a hobby-horse article by our prolific friend ERASTUS WIMAN on "The Capture of Canada" (by commercial union), to judge by the tone of which this poor country is on the verge of ruin unless it can "enlarge its markets" by adding what is at most another State of Indiana or Illinois. It might be highly important to either of these States to again obtain the advantage of a continental market, were it suddenly to exclude itself from it, but we shrewdly suspect that the remainder of the Union would struggle along very comfortably were the trade of either or both of these States suddenly lost to it. Complete commercial union would enlarge the home markets of Canada fourteen-fold; it would enlarge the home market of the United States but one-thirteenth part. Consequently, while beyond doubt advantageous to both sides if both desire it, it will be quite impossible to work up any deep interest in the question in this country.

The Forum contains a very forcible article on "The Possibilities of Agriculture" by Prince P. KRAPOTKIN, showing how absurd are the fears that the earth is approaching, or ever likely to approach the limit of population which it can properly sustain, and two articles on what we may call the "Looking Backward" question, by Prof. GOLDWIN SMITH ("Prophets of Unrest") and Dr. LYMAN ABBOTT ("Industrial Democracy") which stand to each other as poison and antidote; which is which every reader must judge for himself. Both are forcible, and both perhaps contain more truth than error.

BOOKS.

—*Practical Dynamo-Building for Amateurs.* How to Wind for any Output. By FREDERICK WALKER. Revised from second English edition. New York: D. Van Nostrand Co. 16mo, "Science Series," pp. 104, 19 cuts. 50 cents.

The general nature of the work is clearly given by its title; but it also affords a handy mode of familiarizing oneself with elementary electrical practice.

—*The Principles of Mechanics as Applied to the Solar System.* By R. P. THAXTER, San Francisco. P. Erine, agent. Pamph., 8vo, pp. 70, 8 cuts. 50 cents.

A pamphlet advancing various theories of the author as to the dynamics of the universe, which may be read with interest by the "reader, casual or otherwise," whom the author hopes may "reject or approve" the ideas presented, but which can be read with profit only by those whom long study of these abstruse problems has qualified to form intelligent opinions on them.

—*Manual of the Railroads of the United States* for 1890. Showing their Route and Mileage; Stocks; Bonds; Debts; Cost; Traffic; Earnings; Expenses and Dividends; their Organization, Directors, Officers, etc. By HENRY V. POOR. New York: H. V. & H. W. Poor. 8vo; pp. 1,434; 20 colored State maps, and 51 maps of railway systems. $6.00.

The statistics in this volume, which is the 23d annual issue, were reviewed and abstracted in our issue of Aug. 2. The most important improvement over preceding years' editions is the publication of maps of some of the leading railway systems of the country. While these maps are necessarily on a small scale, they seem to have been on the whole, carefully prepared. Each map is inserted opposite the statement of the road which it represents and can thus be conveniently referred to. The selection of the railways to be shown seems somewhat open to criticism. On a hasty search we find no maps of such important roads as the New York Central, New York, Lake Erie & Western and Louisville & Nashville, while single lines like the St. Paul & Duluth, Cape Girardeau Southwestern, and San Francisco & Northern Pacific are each shown by a map. A very good way to remedy this defect will be to considerably increase the number of these maps in future editions. The engraver of these system-maps has omitted to put any scale of miles on them; but we are pleased to see that a scale of miles has been added to the colored State maps, the lack of which has been a most annoying defect.

Probably the greatest improvement that could be made in the book for the benefit of the busy men who use it would be to keep advertisements out of the general index and put the latter next to the front cover, where it could be found without tumbling over the 146 pages of advertising which precede the introduction. It is now impossible for even an expert to find anything in the book without referring to the general index and it should be made as convenient for reference as possible.

As nearly as we can judge in advance of a year's use of the book, the work on the Manual is kept well up to the standard of former years. In the securing of statements of the small local roads and in avoiding omissions, it seems that the editors are growing more successful. The rolling stock statements for the large roads are given with much more detail than heretofore. Monographs of some length on leading companies form, as heretofore, an important feature. The directory of railway officials seems to be brought up to a late date, and much care has been taken to ensure its correctness.

—*Reflections on the Motive Power of Heat, and on Machines Fitted to Develop that Power.* From the original French of N.-L.-S. CARNOT, Graduate of the Polytechnic School. Edited by R. H. THURSTON, Director of Sibley College, Cornell University, etc. New York: John Wiley & Sons. 12mo, pp. 260. $2.

The title page of this little volume hardly covers its contents. It is really a kind of memorial volume of SADI CARNOT, containing, besides the great monograph named in its title, which occupies only 90 of its 260 pages, a life of CARNOT by his brother, a sketch of his work by Prof. THURSTON, a reprint of Sir WILLIAM THOMSON'S original article, written in 1849, which in a measure discovered CARNOT to to the world, 17 years after his death, in 1832; and, finally, what is to us the most striking part perhaps of the whole volume, some hitherto unpublished notes of CARNOT, in which he not only reveals himself as a man, but sets down with a freedom which he did not allow himself in his more formal work his own real impressions and beliefs as to the nature of heat and energy, in respect to which it is enough to say that there is hardly a word or a line which needs to be altered to correspond with what is known to-day. When we further learn that his great work was written when he was only 23 or 24 years of age, the extraordinary character of his genius is at once apparent, and it is well that there should be some work like this to be for his memory "a relic, a memorial, a corner-stone." It is only strange that no one before should have felt the impulse to pay it a similar tribute.

Yet as a matter of fact, from having taken no part in the practical work of developing the steam engine, and from having died so young that his fame did not have time to establish it, the man who first conceived and enunciated the fundamental truths of the whole science of thermodynamics is so little known that "not even his name appears in the biographical dictionaries and in the Encyclopedia Britannica; it is only found incidentally in the article on Thermodynamics," as Prof. Thurston writes with some bitterness, and we may add with a shade of inaccuracy, since CARNOT is also referred to appreciatively in the article on the Steam Engine.

It should be added, however, that the reference which is actually made to CARNOT in the last named article does him a grave injustice. It says:

> The theory of the steam engine as a heat engine dates from 1824, when CARNOT published his *Reflections sur la Puissance Motrice du Feu*, and showed that heat does work only by being let down from a higher to a lower temperature. *But* CARNOT *had no idea that any of the heat disappears in the process*, and it was not until the doctrine of the conservation of energy was established in 1843 by the experiments of JOULE that the theory of heat engines began a vigorous growth.

It is perfectly true that CARNOT did not in his main treatise controvert directly the then established (material) theory of heat. To have done so would have been to deny himself a hearing, and would have been beyond his range of experimental proof; but compare the above statement with the following extracts from CARNOT'S notebook, and its injustice is at once apparent. He says (p. 225):

> *Heat is simply motive power, or, rather, motion which has changed form. It is a movement among the particles of bodies.* Wherever there is destruction of motive power, there is, at the same time, production of heat in quantity exactly proportional to the quantity of motive power destroyed. Reciprocally, wherever there is destruction of heat there is production of motive power.
>
> We can establish the general proposition that motive power is in quantity invariable in nature; that it is, correctly speaking, never either produced or destroyed. It changes form, produces sometimes one sort of motion, sometimes another, but is never annihilated (p. 226).
>
> According to some ideas which I have formed on the theory of heat, the production of a unit of motive power necessitates the destruction of 2.70 units of heat. [This differs by only 15 or 16 per cent. from the true "Joule's equivalent."]

Numerous prior notes announce the same views in a more tentative form. But not only does CARNOT in these sentences put himself abreast with modern science, but he goes beyond its present stage into a region where science has yet to follow him, in the following bold speculation: "But it would be difficult to explain why, in the development of motive power from heat, *a cold body is necessary; why, in [merely] consuming the heat of a warm body motion cannot be produced.*"

In other words, CARNOT had a sufficiently vivid conception of the true nature of heat to imagine an engine in which small modicums of heat were supplied to an expansive body (presumbly) expended in work, again supplied, and so on indefinitely, the heat being thus utilized at its full theoretical value, instead of throwing away three-quarters of it or more, as must be done even in a theoretically perfect engine of the steam engine type. Whether a working engine of this kind ever can or will be devised, so as to involve no theoretical loss, is something which is still as doubtful as in CARNOT'S day The precise form which such an engine should have is as great a mystery to us as ever. But to have conceived of the possibility of such an engine in 1824, which many do not even now perceive, indicates an extraordinarily firm grasp of the true theory of heat.

We need not follow CARNOT'S scientific achievements further, however. Those interested will find them more forcibly set forth in the volume itself. The real purpose of the review, as of the volume, should rather be to rescue CARNOT'S personality from oblivion, and reveal how great a man, as a man, he really was. Almost alone of the really great men of science, CARNOT was born in the purple. At his birth, in 1796, his father was a member of the Directory of France, and later was Minister of War under BONAPARTE, when the young scientist, then aged 4, was a pet of Madame BONAPARTE.

An amusing story is told of his once defying the First Consul; and it is surely a proof of the heredity of talent, and of the many forms which it takes, that a grand-nephew of his should himself have been both a distinguished engineer and President of the French Republic. At 16 CARNOT entered the Polytechnic School; at 18 he had written scientific papers and stood sixth in his class; at 23 he obtained a furlough from military service, and he began a studious and artistic life; at 28 he published his great work on heat (which must have been written some years previously if Prof. THURSTON is right in stating that it was written at the age of 23 or 24—his brother's memoir does not state this, but rather implies the contrary); at 36 he died, having been for years before his death engaged in experimental researches which he did not live to complete. He never married, and his life was singularly uneventful; but his notes, now first published, reveal a man who might easily have become the greatest of scientists could he have lived for twice as many years. Prof. THURSTON and the publisher have rendered a real service to science in making the life and works of such a man more accessible and better known.

REPORTS.

—*Seventeenth Annual Report of the Board of Water Commissioners of the City of Port Huron (Mich.)* April 1, 1890. Pamph., 45 pp. HUGH F. DORAN, Supt.

—*Report of the Trustees of the Sanitary Improvement Bonds of the City of Jacksonville, Fla.* July 1, 1889 to July 1, 1890. Pamphlet, pp. 42. R. N. ELLIS, Superintendent of water-works.

—*The Nicaragua Canal;* its Design, Final Location and Work Accomplished. By A. S. MENOCAL, Chief Engineer. Paper read at the Fourth International Congress

on Inland Navigation, Manchester, July, 1890. 8vo, pp. 29.

A concise résumé of the facts about the canal from the beginning.

—*Report on Proposed System of Sewerage and Sewage Disposal for West Toronto Junction.* By WILLIS CHIPMAN, Civil and Sanitary Engineer. Pamph., 8vo, pp. 18 and folding map.

Mr. CHIPMAN favors the adoption of a "Restricted System," at a total estimated cost of $255,000.

—*Interstate Commerce Commission Proceedings.*—Classification of Common Soap. In this case Proctor & Gamble, the well-known soap manufacturers, applied to have net weight instead of gross weight charged on their goods. The application was granted.—Alleged Excessive Freight Rates on Food Products. In this case the Commission has decided adversely on the motions to dismiss, and have issued an order reducing rates about 10%.

—*First Annual Report of the Board of Water Commissioners of the City of Ypsilanti (Mich.)* W. R. COATS, Constructing Engineer. Pamph., pp. 77.

The report contains a full description of the construction and present status of the works, and is accompanied by several illustrations, some of which were presented in the issue of this journal, dated May 10, 1890. The early construction of a sewerage system is recommended by the engineer.

—*Twelfth Annual Report of the State Board of Health of Rhode Island.* Pamphlet, pp. 222. Providence. CHAS. H. FISHER, M. D., Secretary.

This is a very complete report of its kind. In addition to other data it contains reports from various towns regarding their sanitary condition, including some quite complete information regarding sewers and water-works; also a paper by WM. PAUL GERHARD, C. E., on the Disposal of Sewage of Isolated Country Houses.

—*Seventh Annual Report of the Bureau of Statistics of Labor,* of the State of New York. CHAS. F. PECK, Commissioner. Pub. Doc. 8vo., pp. 138, chiefly tables.

This bureau appears to be doing very valuable work, and certainly unusually complete, energetic, and painstaking work. It is very rare to see any public work of this nature so thoroughly done, with such pains to make a mass of disjointed facts intelligible by abstracts and summaries. We have room for the following tables only, but the report is a mine of information for students of the labor question, the tables, most of them very elaborate, extending so far as to Table W.

STRIKES FOR FIVE YEARS, 1885-89.

YEAR.	Number of establishments reported on strike.	Number of persons engaged in strikes.	Number of strikes successful.	Number compromised or partly successful.	Number unsuccessful.
1885	1,620	52,442	1,202	207	211
1886	3,686	175,369	1,125	847	1,714
1887	1,677	54,240	732	190	755
1888	1,027	24,092	501	83	443
1889	*1,374	32,783	872	107	345
Totals.	9,384	338,926	4,432	1,434	3,468
Per cent			47.2	15.3	37.0

* Fifty, 0.5 per cent., pending at close of investigation.

GENERAL STRIKES, 1885-89.

YEAR.	Number of establishments.	RESULTS OF STRIKES. Successful.	Partly Successful or compromised.	Unsuccessful.	Number of persons engaged in strike.
1885	1,234	943	180	111	30,779
1886	2,423	692	690	1,041	106,312
1887	766	267	143	356	21,173
1888	396	170	37	189	7,853
1889	404	261	54	89	7,675
Totals	5,223	2,333	1,104	1,786	173,792

THREATENED STRIKES, 1885-89.

YEAR.	Number of establishments.	Number of persons affected.	RESULTS OF STRIKES. Successful	Partly successful or compromised.	Unsuccessful.
1886	71	96	55	7	9
1887	69	1,001	54	1	14
1888	127	1,547	115	7	5
1889	331	3,219	296	12	23
Totals	598	5,863	520	27	51

CAUSES OF STRIKES.

A summary of the "causes of strikes for five years, 1885-89," shows that the predominating causes were questions of wages and hours of labor. A detailed statement of the causes of strikes will be found further on, under its proper caption.

Strikes occurred in 3,888 establishments, being 41.4 per cent. of the whole number for an increase or against a reduction of wages; of these, 2,757, or 70.9 per cent., were successful; 1,128, or 29 per cent., were unsuccessful; 3 strikes, or 0.1 per cent., were not settled and are still "pending;" 1,777 strikes, being 18.9 per cent. of the number reported in table A, were for "change in hours of labor;" of these 1,360, or 76.6 per cent. were successful and 23.4 per cent. were unsuccessful.

—*Catalogue of the University of Illinois,* 1889-90. Pamphlet, 12mo., pp. 104.

The college numbers 469 students in all, 392 of whom are officially catalogued as "gentlemen" and 77 as "ladies," being in each case the gratifyingly large proportion of 100% of all those in the college, a much larger percentage of "gentlemen" (we will say nothing about the "ladies") than we have ever before chanced to encounter in any collection of male human beings. We feel tempted to quote something from the Professor at the Breakfast Table, beginning, "*Man*, sir! *Woman*, sir!" but with this hint forbear. When even college faculties do not perceive how odious is such misuse of words, it is useless for the mere editor to say much.

SOCIETY PROCEEDINGS.

Engineers' Society of Western Pennsylvania.—At the last regular meeting, 27 members present, Mr. PHINEAS BARNES delivered an address on "Sundry Rolling Mill Appliances." The society passed a set of resolutions condemning the dam proposed by the government at Herr's Island, in the Allegheny River, and requesting Col. W. E. MERRILL who has charge of the work, to recommend some form of movable weir.

New England Roadmasters' Association.—The eighth annual meeting will be held at the American House, Boston, Mass., Aug. 20 and 21. The first session will be opened at 1.30 P. M., Aug. 20, and adjournment will be taken on the evening of Aug. 21. The following questions are to be discussed:

1. Best and most economical method of repairs to track in the winter and spring months. *Committee:* J. W. Shanks, New London Northern; F. C. Clark, Housatonic; J. W. McNamara, Fitchburg.

2. Inspection of road bed—daily and yearly inspection; premium system. *Committee:* J. R. Patch, Conn. River; C. B. Lentell, Boston & Albany; R. P. Collins, Old Colony.

3. Experience with frogs and switches now in use, and the greatest cause of their renewal. *Committee:* L. J. Spaulding, Fitchburg; A. C. Stevens, Boston & Maine; S. B. Bodwell, Jr., Boston & Maine.

4. Railroad ties, dimensions, position and number to be laid per mile under 56, 60, 72 and 76 lb. rails. *Committee:* A. C. Bean, Central Vermont; R. Hyland, Cheshire; W. E. Clark, Vt. Valley.

5. Review of previous year's discussions. *Committee:* J. S. Lane, N. Y., N. H. & H.; P. A. Eaton, Concord & Montreal; E. K. Post, N. Y., N. H. & H.

The usual facilities will be furnished for the exhibition of railway appliances.

G. L. R. FRENCH, Sec. pro tem.,
Northampton, Mass.

Iron and Steel Institute.—At the meeting in New York of the British Iron and Steel Institute in October the following are among the papers expected to be presented, according to the Secretary's provisional list:

"American Blast Furnace Yields." James Gayley, Pittsburg, Pa.

"Testing Materials of Construction in the United States." Hunt & Clapp, Pittsburg.

"The Manufacture of Steel in the United States." Henry M. Howe, Boston.

"The Thomson Electric Welding Process." Elihu Thomson, New York.

"The Manufacture of Spirally Welded Steel Pipes in the United States." J. C. Bayles, New York.

"The Development of the Iron Manufacture of Virginia." E. C. Pechin, Cleveland, O.

"The Use of Water Gas in the United States." B. Loomis, Hartford, Conn.

"The Coke Industry of the United States." J. D. Weeks, Pittsburg.

"Recent Progress in the Manufacture of War Material in the United States." W. H. Jaques, Bethlehem, Pa.

"The Composition and Wearing Qualities of Steel Rails." Chas. B. Dudley, Altoona, Pa.

"The Protection of Iron and Steel Ships against Foundering from Injury to their Shells, including the use of Armor." Sir N. Barnaby, K. C. B., London.

"The Recent Development of Marine Engineering." A. E. Seaton, Hull, England.

National Electric Light Association.—The summer meeting will be held at the Stockton Hotel, Cape May N. J., from Aug. 19 to 23. Among the papers to be presented are the following:

1. "Electrical Industries and the World's Columbian Fair," J. P. Barrett, Chicago.

2. "Electric Light as Supplied to Steam Railroads," W. H. Markland, Altoona, Pa.

3. "Standards of Economy in the Generation of Power and Steam Under Best Conditions," H. M. Swetland, New York City.

4. "Triple Expansion High Speed Engines for Central Station Work," Ed. F. Williams, Beloit, Wis.

5. "The Model Boiler-Room and the Duties of a Fireman," Jarvis B. Edson, New York.

6. "Ferranti Station at London, England," Caryl Haskings, Lynn, Mass.

7. "The Proper Care and Management of Alternating Currents," T. Carpenter Smith, Philadelphia.

8. "Distribution of Energy by Alternating Currents and Transformers and the Proper Method of Proportioning Conductors," A. L. Rohrer, Lynn, Mass.

9. "The Proper Basis for Determining Electric Motor Rates," H. L. Lufkin, New York.

10. "Actual Cost of Furnishing Arc Lighting (1,200 c. p. and 2,000 c. p. Lamps) Under the Best Possible Conditions," J. C. Ayer, St. Louis.

11. "Municipal Ownership of Electric Lighting Plants," M. J. Francisco, Rutland, Vt.

12. "Accidents in Electric Lighting Stations and Plants," Prof. Charles R. Cross, Boston.

13. "Care and Labor in Electric Light Stations and Its Value," A. J. DeCamp, Philadelphia.

14. "How Can the National Electric Light Association Best Serve the Interests of Central Station Companies?" C. R. Huntley, Buffalo, N. Y.

The Institution of Mechanical Engineers.

[FROM OUR LONDON CORRESPONDENT.]

Summer Meeting, July 29.—The Institution of Mechanical Engineers holds annually two provincial meetings, one in the summer and a second in the autumn. It is, however, only the first of these that is of any importance, no one taking much notice of the second, while the summer meeting is the principal event of the year. This summer, Sheffield was the place of meeting, and a goodly number of members traveled down to the grimy Yorkshire town on July 28, in order to attend the first sitting of the meeting, which was held on the following day.

It may be said at once that the meeting was one of the dullest we have attended for a very long time. In the first place, the management was bad both at the sittings and during the excursions; in the second place, the majority of the papers contributed were of a poor character; and in the third place, the big steel makers, who might have made the meeting one of the most successful on record, churlishly shut their doors.

Sheffield, as every one knows, is the ancient home and stronghold of the steel trade. It was here, one hundred years ago, that HUNTSMAN commenced making crucible cast steel by a process which remains in vogue up to the present day. It was here, also, that that truly great man, now known as Sir HENRY BESSEMER, made his famous assault on HUNTSMAN'S process, and, failing in his attack, established a new branch of metal industry which has proved the most important metallurgical feature of this age, and perhaps of any age.

Sheffield presents a more striking contrast of conservatism and enterprise than any other town in the United Kingdom. Side by side with firms which are making crucible cast steel, in the way HUNTSMAN taught their great-great grandfathers 100 years ago, we see firms such as the CAMMELS, who employ in all about 5,000 men, the BROWNS, FIRTHS, VICKERS, and JESSOPS, who produce, by the aid of the best modern appliances, vast and complex steel structures. There are few important industrial centers in England with less facilities for water communication with the sea, and yet here, and here only, are made the massive armor plates with which the ships of the Royal Navy are protected. The town of Sheffield itself is one of the most unlovely in England. The streets are squalid and ill-kept, the buildings are poor and mean; while the everlasting fall of smoke which blackens the town, and shuts out the sunlight from above, depresses the visitor to the verge of melancholy. It has no such saddening effect on the native. The Sheffielder is proud of his mirky surroundings. "Where there is smoke there, is gold," is his favorite maxim. He is not like the sow that has been washed, simply because no effort toward cleanliness has ever been made.

There were five papers read and discussed during the two days' sitting. They were as follows: "On Steel Rails considered Chemically and Mechanically," by C. P. SANDBERG, of London; "On Recent Improvements in the Mechanical Engineering of Coal Mines," by EMERSON BAINBRIDGE, of Sheffield; "Description of the Park Gate Iron and Steel Works," by C. J. STODDART; "Description of the Sheffield Water Works," by E. M. EATON; "Description of the Loomis Process for making Gas Fuel," by R. N. OAKMAN, Jr., of London.

There were three other papers on the programme, but the reading of these was left over until the next meeting.

The chief and most interesting paper on the list was that on steel rails. The author, Mr. SANDBERG, is Engineer to the Swedish Government railways, and also the most prominent professional expert on steel rails in Europe, and the reading of his paper attracted some of the leading steel makers and others to hear it.

(To be continued.)

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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Advertising rates. 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—Next meeting, Aug. 16. Secy., Howard Murphy, 1122 Girard St.

Engineers' Society of Western Pennsylvania.—Next meeting, Aug. 19. Secy., S. M. Wickersham, Pittsburg, Pa.

Engineers' Club of Cincinnati.—Next meeting, Aug. 19. Secy., J. F. Wilson.

American Society of Civil Engineers.—Next meeting, Aug. 20. Secy., John Bogart, 127 E. 23d St., New York.

Engineers' Club of St. Louis.—Next meeting, Aug. 20. Secy., W. H. Bryan, 30 South 7th St.

New York Railway Club.—Next meeting, Aug. 21. Rooms, 113 Liberty St.

New England Roadmasters' Association.—Annual meeting, Aug. 21 and 22, Boston, Mass.

Western Society of Engineers.—Next meeting, Sept. 2. Secy., J. W. Weston, 230 La Salle St., Chicago.

Association of Civil Engineers of Dallas.—Next meeting, Sept. 5. Secy., E. K. Smoot, Elm and Austin Sts.

Civil Engineers' Club of Cleveland.—Next meeting, Sept. 9. Secy., C. O. Palmer, 22 Cedar Ave.

Civil Engineers' Association of Kansas.—Next meeting, Sept. 10. Secy., J. C. Herring, Wichita, Kan.

Engineering Association of the Southwest.—Next meeting, Sept. 11. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

American Society of Railway Superintendents.—Annual meeting at New York on the day preceding the fall meeting of the General Time Convention. Secy., C. A. Hammond, 350 Atlantic Ave., Boston, Mass.

A PROBLEM in surveying of some interest and practical importance, submitted by Mr. F. HODGMAN, of Climax, Mich., Secretary of the Michigan Engineering Society, appears in our advertising columns. As it was sent to us in a form which made it a *quasi* advertisement of an excellent manual of surveying it could not well appear elsewhere, but we have with pleasure consented to receive and examine the responses, and shall probably publish the best of them. The ability to solve correctly a problem of this nature, depending as much on judgment and good sense as on mere mathematical knowledge, is a very good test of one's competency to deal with the complicated surveying problems of the same general nature which are constantly coming up.

THE power of one man, when he throws himself heart and soul into any good cause, may perhaps yet be illustrated by a great reform in the character of the highways of the State of New York as the result of the labors of Mr. WM. A. SWEET, of Syracuse, President of the Roads Improvement Association, who is deserving of great honor for his unselfish labors to this end. As one of his good works, Mr. SWEET has put down at his own expense 600 ft. of Belgian Block pavements in Syracuse, to try and awaken that benighted city to a sense of its deficiencies; as another, he employs a secretary at his own expense to work up interest in the Roads Improvement Association; as the third and greatest, he gives freely of his time and labor, as well as of his money, to urging improvement in our present disgracefully bad methods of highway maintenance. As a result of his and others' public-spirited labors there is likely to be another vigorous campaign at Albany to pass some one or more of the measures which were before the Legislature last year, as we recorded at the time, but which then failed of passage. The bills providing for a State Board of Highway Commissioners, and for the construction under State auspices of some 3,000 miles of really good roads to connect the county seats of the State will both be reintroduced, as also a bill requiring the supervisors of each county to raise money enough by direct taxation to build a certain distance of really good road every year. The bill to connect the county seats throughout the State by really good roads seems to us to be most hopeful in principle. No doubt in many cases the roads so selected would not be those which there was most urgent need to improve; but a certain discretion might be vested in the commissioners; the roads would in no case be made any better than they should be, and the educative effect of such samples of good roads within easy reach of every resident of the State would be immense, ensuring that all the more important roads remaining would be speedily improved as a matter of competitive necessity. It is our misfortune that the good-roads era must begin in this country after the railway instead of before it, as it did in Europe; but begin it must, before long.

THE real meaning of the public outcry about the details of the KEMMLER execution can only be that the modern public finds it hard enough to tolerate horrors which ages of precedent have inured it to, and absolutely refuses to tolerate even much lesser horrors with which precedent has not made it familiar. Its gorge rises at even the most merciful *new* details of what must be at best a painful scene; for, as Gen. SHERMAN said about war, "executions are cruel; you cannot refine them." There can be no rational doubt that, with all the seemingly needless bungling about the force of the current, the criminal's life was instantly extinguished and his apparent signs of life merely those which accompany the application of strong currents to any corpse, even those which have been dead for many hours or even days. And even if he had merely lost consciousness the execution was as merciful as any could be. There is no rational man who if he had to choose, would not at this moment choose to die as KEMMLER did, rather than by the hangman. Yet the newspapers which most strenuously and shamelessly follow the popular whim, were the loudest in silly cries about the "tortures" of the criminal, and other "heart-sickening circumstances;" and these were even echoed from over the ocean by men who should have had more sense. Rational or irrational, however, popular feeling is a great force, which must be reckoned with; and may yet be strong enough to cause a repeal of the present law, or, possibly, of the death penalty in any form. There is also one rational ground for the present outcry, perhaps, in a feeling that a barbarous act should be barbarously performed by rude and barbarous men, and that it becomes more offensive when the aid of scientists and a scientific plant is called on for such an act. From any point of view the popular excitement on the subject is an odd social phenomenon. The modern man is almost mawkishly sympathetic, but he never made quite such a fool of himself, on either side of the ocean, as in his excitement over the "barbarities" of the KEMMLER execution. The law is a good one, and should be allowed to stand.

A CONTRACTING firm writes to us from Pecos, Tex., as follows:

Will you kindly rule on the following: If a contract is taken to do clearing at a certain price "per acre," and the engineers of a company order us to clear between certain stakes, does not the contract call for payment for the area between those stakes? Kindly reply in your journal.

There is, perhaps, no small cause for dispute about contracts which has more frequently come up than this. We know of one instance in which a contractor made an enormous profit on clearing alone by a successful quibble on the point raised by our correspondent. It was in Mexico, where there was comparatively little clearing, and that little of scattered mesquite trees costing hardly anything to clear, and necessarily extremely hard to measure. The contractor, either by accident or intention, secured an order in writing to "clear the entire right of way" on his contract, which was about 100 kilos, or 62 miles, long, and some 30 m., or 100 ft., wide, thus including an area of some 3,000,000 sq. m. His bid, if we remember correctly, had been one cent per square metre, or some $25 per acre. Dispute at once arose as to the quantity of clearing, which was not at all liberally estimated by the engineer; and, whether provoked by this contest or by previous intent, the contractor claimed in the courts and was awarded one cent per square metre for the entire area, giving him some $30,000 gross for work which certainly did not cost him over $500.

But this was in Mexico, with courts looking only to the letter, and not familiar with contracting practice. The decision was contrary to reason and equity, and no American court, in our judgment, would or ought to make any such decision. Supposing our correspondent were ordered to do the grading between certain stations, what does he expect to be paid for, all the grading which might possibly be done between them, or merely that which the ground calls for? Similarly, when he is ordered to clear between certain stations, he is only entitled for payment on the area actually cleared, unless otherwise explicitly stated in the contract; but there should be no hair-splitting in the measurement of this area. What the contractor is entitled to in law and equity, and can collect, in our judgment, is clearing for the full width of the right of way, and for the distance on the center line along which there is any sensible amount of clearing, a scattered tree or two being disregarded, but no attempt being made to "equate" light clearing into equivalent heavy clearing. Many modern contracts made no payments at all for clearing or grubbing.

THE census authorities have distinguished themselves by the early publication of Bulletins Nos. 7 and 8, these being the first which have reached our table giving the results of the June 1 census. Bulletin No. 7 opens with a truth which we are glad to see is so keenly appreciated: "Rapidity of publication ranks second to accuracy [only] in all matters appertaining to a census;" and proceeds to give a very complete summary of State debts, abstracted in another column, from which it appears that in the decade 1880-90 there has been a decrease of 58.02 millions in the total of State debts, from 296.42 millions in 1880 to 238.40 millions in 1890, or almost exactly 20 per cent. Taken in connection with the rapid decrease of the na-

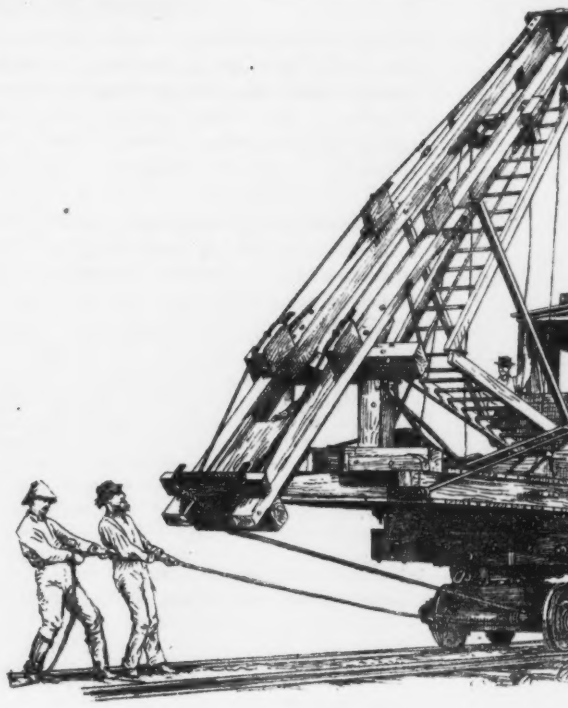

FIG. 1. PILE DRIVER, SHOWING MODE

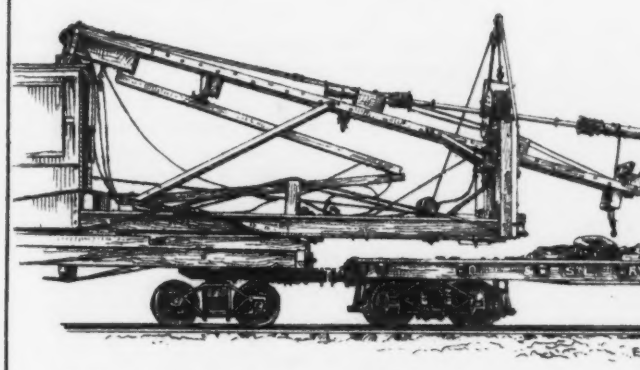

FIG. 2. PILE DRIVER LOWERED FOR TRANSPORTATI

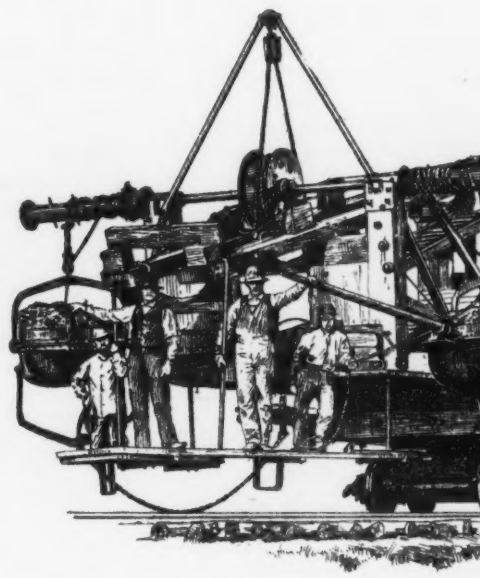

FIG. 3. DITCHING ATTAC

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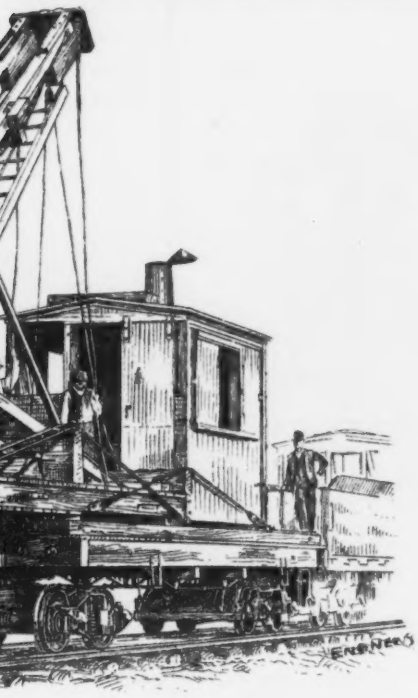
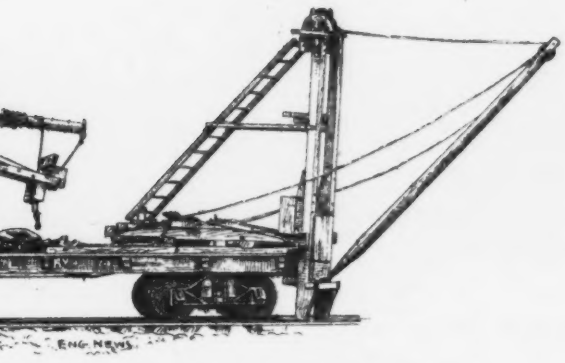
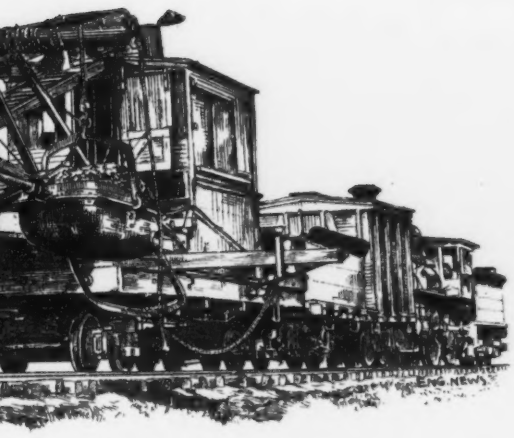


ODE OF RAISING LEADERS.



RTATION, WITH SPECIAL DRIVER IN FRONT.



ATTACHMENT TO PILE DRIVER.

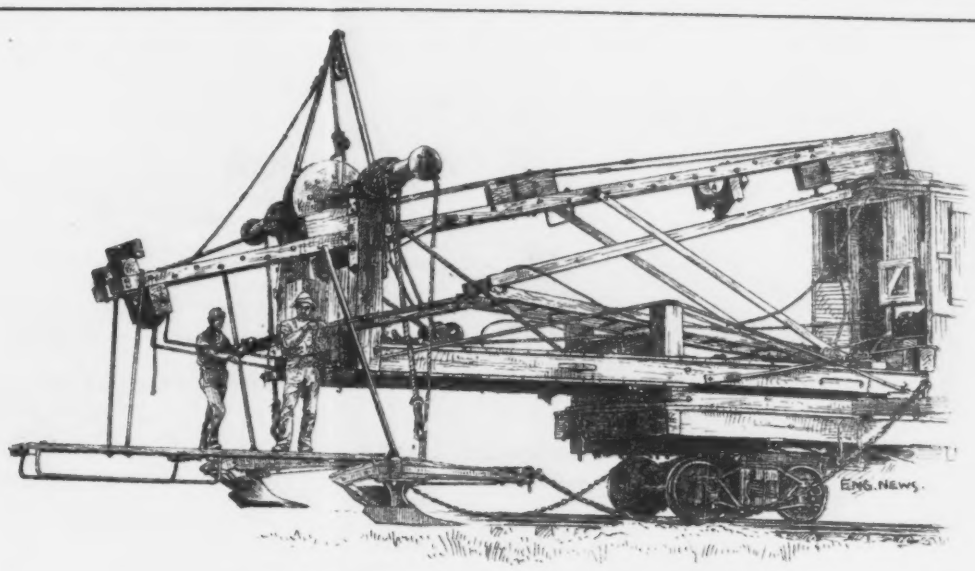


FIG. 4. MANNER OF WORKING HARDPAN PLOWS.

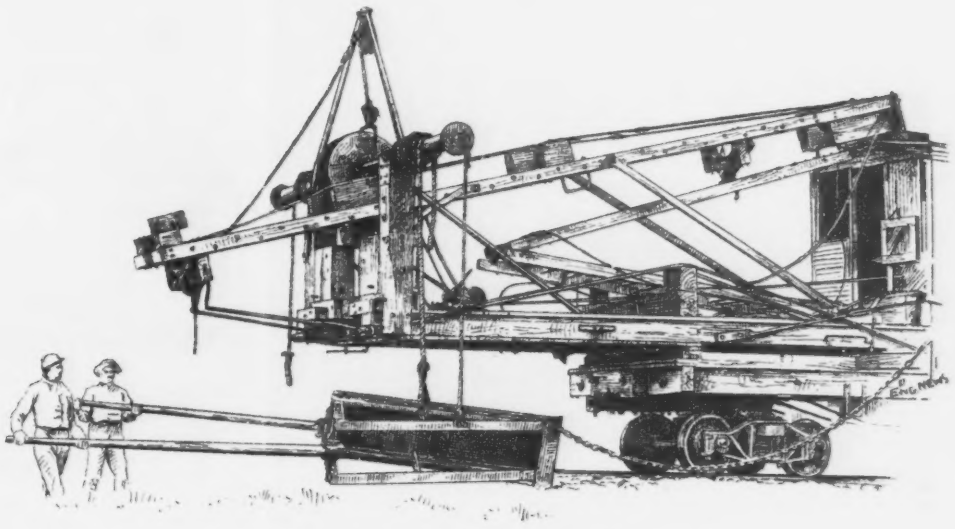


FIG. 5. WEDGING PLOW OR SIDE SCRAPER.

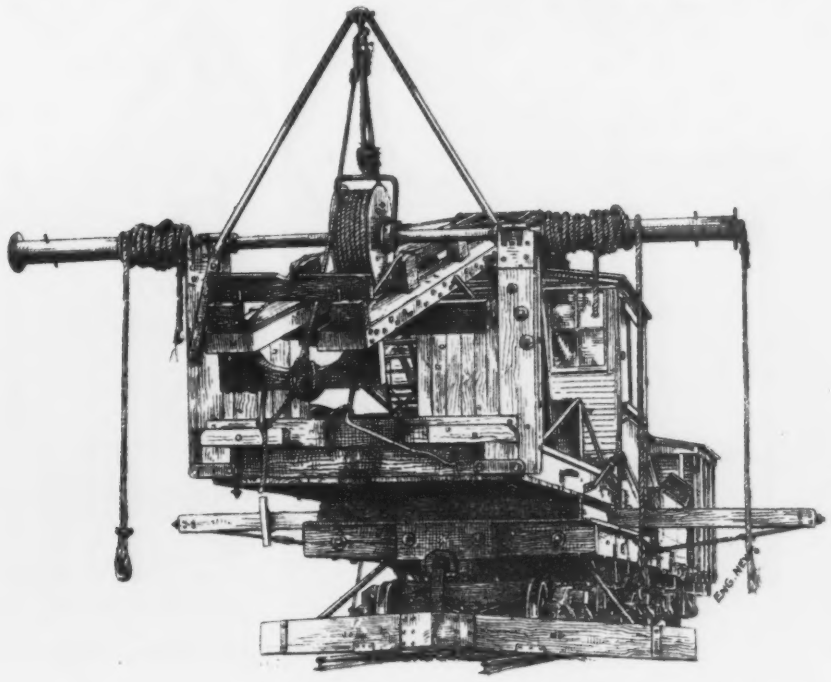


FIG. 6. PLOW FOR LEVELING DUMP.

Combined Pile Driver, Ditcher and Derrick,

Omaha & St. Louis Railway.

Designed by A. E. Buchanan, Superintendent.

Chas. Hart & Sons, Lith., 88 Vesey St., N.Y.

tional debt, this decrease is very gratifying, in spite of the fact that nearly half the decrease (28.52 against 29.50 millions) was by enforced scaling down of bonds by the States of Virginia, North and South Carolina, Louisiana, and Tennessee.

In net debt (debt less cash in hand) the change is still more striking, viz., from 204.50 millions in 1880 to 132.34 millions in 1890, a decrease of 72.16 millions, or 35½ per cent. The New England States have almost wiped out their debts (26.83 down to 7.29 millions); the Middle States have done almost as well (18.55 down to 5.32 millions); the Southern States, not including Missouri, show 2.58 millions of honest decrease, as well as 28.52 millions of dishonest decrease (127.56 down to 96.46 millions), and even the Western and Pacific States, despite their rapid growth of population and chronic need of capital for development, show also a heavy decrease (31.56 down to 23.26 millions). Plainly this is a debt-paying country from habit and principle, and not alone from abundant revenue. All this State decrease was effected only by direct taxation. Eighteen States show no debt, against only 12 in 1880; three northern and four southern States alone show an increase, all of trifling amounts except Indiana, which has increased her debt seven-fold from the nominal sum of half a million. No northern State has enough debt left to be a sensible burden, and the southern debts are not really heavy. The national debt less cash in treasury has decreased from 1,922.52 to 923.38 millions, or 999.14 millions, or 52 per cent. A like showing was never seen nor dreamt of before in the history of any nation or people. We may well be proud of it.

Bulletin No. 8 is on the slate mining industry for the calendar year 1889, and the collection of data for it was begun Jan. 1 instead of June 1; but such prompt work is even then most creditable. It also begins by "recognizing the value of the prompt publication of statistics," which we may believe is to be the motto of the eleventh census. It shows that the slate industry has, in round numbers, more than doubled in every department since 1880; a marvelous growth. About 80 per cent. of the slate produced is for roofing. Twelve States at present produce slate, viz.: the Atlantic coast States east of the Alleghanies (Maine, Maryland, Vermont, New York, New Jersey, Pennsylvania, Virginia and Georgia being the only States in which deposits are now worked), about 99 per cent. of the whole product being from these States, and about 60 per cent. from Pennsylvania alone. In addition, there is a little slate produced in northern Michigan, California, Arkansas and Utah, with known deposits of value in Tennessee and other States. There are 206 quarries, half of them in Pennsylvania, and all but five in the Atlantic States; $10,042,000 of capital invested, and nearly 6,000 men employed, chiefly Welsh or of Welsh descent. The bulletin closes with a complete summary of firms producing slate.

Family and Meter Water Rates in the United States and Canada.

[CONCLUDED.]

By referring to the headings of Table 1—R, given in our issue for last week, it will be seen that the rates included are, first, the general family rate or charge for introducing water to the premises for general household purposes. This column is a very significant one, since it is absolutely the lowest price for which water will be furnished, and constitutes the entire rental of a large number of consumers, often people who for many years previously used impure well water because they thought they could not afford to pay even this price for "city water." The other rates are for pan water-closet, bath tub, wash bowl or basin (in addition to the kitchen or first faucet), horse and carriage with use of hose for washing the latter, cow, and hand hose for lawns. Following these is their total, which constitutes the sum which must be paid for all these services. If the various schedules mention any reduction for more than one service, the totals are made up accordingly. The meter rates are in cents per million gallons, highest and lowest rates. Immediately following the total family rental is the average cost of the works in question per family, five being always taken as the size of the family. This last has been given as an important adjunct to the table, since a low cost plant, other things being equal, should furnish water at a low rate. Further comments and the tables show whether this is true.

All we can present in these pages is the results by States of averages of the data for all works, public works and private works, which we have done in Table 1—R, and the results by groups of States, the United States and Canada of averages of populations, total family rates and cost of works per family, for which see Table 2–R.

No further explanation of these tables is needed here, but it may be well to add that the full table of rates in the body of the MANUAL is preceded by an introductory page, setting forth in detail the methods employed in making up the tables.

TABLE 2–R.

UNITED STATES AND CANADIAN WATER RATES—AVERAGES BY GROUPS OF STATES AND FOR THE UNITED STATES AND CANADA OF THE POPULATION, TOTAL WATER RENTAL PER FAMILY AND TOTAL COST OF WORKS PER FAMILY, SHOWN FOR ALL WORKS, FOR PUBLIC WORKS AND FOR PRIVATE WORKS.

	Population,		Total rental per family.		Total cost per family.	
NEW ENGLAND.	No.	Av. Pop.	No.	Av. rental.	No.	Av. cost.
Av. of all works....	169	14,055	161	$26 61	168	$116.02
Av. of pub. "	75	22,989	73	23.42	75	118.60
Av. of priv. " ...	94	6,927	88	28.12	93	109.18
MIDDLE.						
Av. of all works....	213	32,095	196	24.12	211	111.78
Av. of pub. " ..	77	76,352	73	19.36	77	110.12
Av. of priv. "	136	7,184	123	26.94	134	121.73
SOUTH ATLANTIC.						
Av. of all works....	35	18,009	33	27.48	35	65 46
Av. of pub. " ...	17	23,106	14	23.79	17	67.87
Av. of priv. " ...	18	13,191	19	30.20	18	61 51
SOUTH CENTRAL.						
Av. of all works....	27	33,970	27	35 91	26	94.85
Av. of pub. "	5	32,800	5	31.6	5	117.83
Av. of priv. "	22	34,276	22	36.88	21	89.84
NORTH CENTRAL.						
Av. of all works....	150	24,717	145	21.55	150	86.71
Av. of pub. "	92	32,132	88	18 73	92	85.89
Av of priv. "	58	12,955	57	25.92	58	89 89
NORTHWESTERN.						
Av. of all works....	94	13,970	91	24.91	93	79 68
Av. of pub. "	44	13,538	42	20.77	44	58.37
Av. of priv. "	50	14,350	49	28.46	49	97.39
SOUTHWESTERN.						
Av. of all works....	59	21,445	52	37.73	58	107.89
Av. of pub. "	15	40,307	14	32.53	15	126.52
Av. of priv. " ...	44	14,560	38	39.64	43	91.03
PACIFIC.						
Av. of all works....	46	14,899	43	45.64	46	233 39
Av. of pub. "	9	15,133	9	29 32	9	62.22
Av. of priv. "	37	14,829	34	49.96	37	275.88
UNITED STATES.						
Av. of all works....	793	22,358	748	26.88	787	106.63
Av. of pub. "	334	37,223	318	21.55	334	102.09
Av. of priv. "	459	11,541	430	30.82	453	117.28
CANADA.						
Av. of all works....	38	20,189	32	23.98	38	120.04
Av. of pub. "	27	25,133	23	21.07	27	125.16
Av. of priv. "	11	8,964	9	31.43	11	72.67

Table 1—R will be of greatest interest to those who wish to compare State with State, or the rates of a particular city with the average for the State in which it is located. These averages can be much more conveniently used for the latter purpose in their natural position in the MANUAL at the end of the rates for each State, where they will be found.

Turning to Table 2–R, we find the average total family rate charged for water from 748 works in the United States to be $26.88; for 318 public works, $21.55; and for 430 private works, $30.82—that is, the average total family rate of the 430 private works is $9.27, or 43 per cent. greater than that of the 318 public works. Looking at the figures for the various groups, we see that in each one of them the rates for private are greater than those for public works, ranging from $4.70 greater in the New England to $20.64, or 71 per cent., in the Pacific States. Turning to Table 1—R, we see that in every State and territory of the Union, and in every province of Canada, private works show a higher total family rate than public, the differences here being very slight in some cases: Maryland $19 against $20.80, or but $1.80; and very great in others, as in Nova Scotia, $16.75 against $56.20, or a difference of $39.45. It should be stated that in Maryland the averages are for but four works, of which those at Baltimore are the only public: and that in Nova Scotia the averages are for two public and one private works, all in small towns.

Both the lowest and highest single rentals per family are for company works, $3.25 at Pineville, Ky., and $94.20 at San Angelo, Tex. But while such low rates prevail for this one company, the next lowest company rentals are: $14 in Chillicothe, O., and $14.50 at Wadsworth, O., with but few below $20; while in the city of Washington the total family charge is but $7.25; in Elgin, Ill., $10; Allegan, Mich., $10.50; in Minerva, O., $12; and in at least 20 cities and villages having public works below $15.

Our next inquiry is, since the private works charge a uniformly higher rate, is it not true that their plants are more expensive, and that thus a higher price for water is essential? If this be so, then, other things being equal, the advocates of private ownership have lost one of their strongest points. Referring to Table 2—R, we see that in the New England, the two Southern and the South western groups, the average cost per family is less for private than for public works; while in the remaining groups the reverse is true. The averages for the whole United States show a cost of $102.09 for all public, against $117.28 for all private works. These are largely affected by the excessive cost of private over public works in the Pacific group, $213.66. These figures are doubtless considerably exaggerated by the inclusion of the cost of some irrigation works used in connection with those for city supply. It must also be remembered that the averages of cost in this group are for 9 public against 37 private works, and that for the whole United States the average population for the cities under consideration is 37,223 for public and but 11,541 for private works; while in the Pacific States the figures are 15,133 on public, against 14,829 on private works. In addition, some of the works in the Pacific States have extensive systems of storage reservoirs and long and costly aqueducts, especially San Francisco, which make necessary an unusually high cost per family.

In the Middle States we see a slightly higher cost for private than for public works, but here we have a much smaller average population on the first than on the last, 7,184 against 76,352, while in addition the population on public works is very compact. Both of these factors reduce the per family cost of public works.

As there is so wide a diversity in the Pacific States, we will, for the time, leave them out of our calculations, when we find that for the remaining seven groups the average cost of all works is $101.53; public works, $102.53; private, $98.95. By examining the averages for the various States, Table 1—R, we see that they are about equally divided between higher cost private and higher cost public works. It will now be helpful to place side

by side the differences in rental per family and cost per family, with the percentages of each, as shown in Table 3---R.

TABLE 3.—R.

	Averages of total rate per family.				Averages of total cost per family.			
	Public.	Private.	Dif.	Per cent. of dif.	Public.	Private.	Dif.	Per cent. of dif.
N. E.	$23.42	$28.12	$4.70	20	$118.60	$109.18	— $9.42	— 8
Mid	19.36	26.94	7.58	39	110.12	121.73	+ 11.61	+ 11
So. Atl.	23.79	30.20	6.41	27	67.87	61.51	— 6.36	— 9
So. C.	31.6	36.88	5.28	17	117.83	89.84	— 27.99	— 42
No. C.	18.73	25.92	7.19	38	85.89	89.89	+ 4.00	+ 5
N. W.	20.77	28.46	7.69	37	58.37	97.37	+ 39.00	+ 68
S. W.	32.53	39.64	7.11	22	126.32	91.03	— 35.29	— 28
Pac.	29.32	49.96	20.64	71	62.22	275.88	+213.66	+343
U. S.	21.55	30.82	9.27	43	102.09	117.28	+ 15.19*	+ 15*
Can.	21.07	31.43	10.36	50	125.16	72.67	— 52.49	— 42

* If we again leave out the Pacific States we have the cost, $102.53 for public, against $98.95 for private, a difference of $3.58, or 3.5 per cent., in favor of the private works of the remaining seven groups.

There are such wide variations in the percentages of cost of works per family, and so many factors causing the same that no very reliable deductions can be drawn from these alone. In fact, they were not included for that purpose, but for comparison with the water rates. We see by making such a comparison that the cost of the works has little to do with the variation in price, and certainly does not constitute the reason why private works charge more than public for water, for we find the private works in New England costing 8 per cent. less than public, and charging 20 per cent. more for water.

In the next group, the Middle, the private works have cost 11 per cent. more than the public, while the rates are 39 per cent. higher, the relation between these percentages being as 1 to 3.54. The Pacific group, with its enormous excess of 343 per cent. in cost of private works, shows rates but 71 per cent. higher, and whatever effect the cost of irrigation works may have had upon the averages for the private works of this group, it certainly accounts for but a small part of their excessive cost, and in no measure for the disproportion between the difference in rates and cost. There is but one conclusion. Private works charge as high rates as they can in consistency with business principles. If they have high cost works they generally make good use of the fact by charging high rates; but there is no trace of a fixed relation between the two. The latter is shown by the South Central group, where the private works have cost 42 per cent. less than the public, and the charges are 17 per cent. higher for the former than for the latter; and in contrast we have the Northwestern group, with their private works costing 68 per cent. more than their public and their rates but 37 per cent. higher.

One point not yet mentioned needs attention. Money to pay either a part or the whole of the interest on the bonded indebtedness of public works is often raised by taxation, and it might be urged that this accounts for the lower rates charged by public works. But this is offset by the hydrant rental, which is almost invariably paid to private companies, the money for which is always raised by taxation.

Regarding the rates charged for the various fixtures little need be said. The general practice seems to be to charge for the first faucet, the so-called family rate, from one-fourth to one-third of the total charges for the seven purposes included in the table. There is more reason for this than at first seems evident, since by far the greatest amount of water is drawn from the first or kitchen faucet, and where a family has but one faucet all, or nearly all, the water they use is taken from it.

A great many works make no additional charge for one extra set wash basin, but most charge for the third basin, and it is often the case that where no extra charge is made for the second basin the charge for the first fixture is high enough to make up for it. There is one pernicious feature in nearly all the schedules. A lower rate is charged for pan than for other forms of closets. These closets undoubtedly use less water than some of the other styles, but to put a premium, as it were, on their use is a mistake, since the best plumbing practice excludes them altogether. Besides there are other forms which use little or no more water. If a discrimination is necessary the pan closets should not be allowed at all.

In considering meter rates we find a very wide range in prices. In nearly every State the private works charge higher meter rates than do the public. About two-thirds of the works under consideration give meter prices on their schedules, and most of these have a sliding scale. As we stated in the first part of this article, the average meter rates are given for each State in Table 1—R. The averages for groups of States, the United States and Canada are as follows:

Range of Meter Rates.

N. E.	30.14-14.85
Mid	23 45-12.53
So. Atl.	33.45-14.62
So. C.	36.35-25 34
No. C	30.92-12.57
N. W.	45.79-22.66
S. W.	54.3 -25.26
Pac.	40.48-24.81
U. S.	36.71-19.05
Canada	44.62-20 18

The above figures differ from all previously given, in that they are not the averages of all the meter rates in the States included, but are obtained by dividing the sums of the averages of each State by the number of States or Provinces. The results, however, are approximately the same by either method. The lowest meter rates are in the Middle States, the range being from 23.45 to 12.53 cents per thousand gallons. The highest are in the Southwestern group, 54.3 to 25.26 cents.

In concluding we wish to note that the evidence borne by the schedules of rates which we have received shows an urgent need for reform in the methods used in establishing rates. At present there is the utmost diversity in the charges. Many schedules are copied from others. Some have not been revised for ten or a dozen years. In making up rates for new works the cost of the plant and its future operating expenses are often not taken into account, but the practice in some other city or cities is taken as a guide, or, as has been said, rates are copied verbatim. Now and then a city has taken pains to ascertain as nearly as possible the actual cost of water for various uses. This should be done for every works. Where meters are not used this is impossible. But the introduction of meters is very desirable, and certainly any village or city will be repaid if it purchases enough meters to experiment on these lines.

If an abundant supply of water for immediate use is at hand few seem to care how much is used, and this being the case, enough money to meet expenses is often raised in what is thought to be the easiest way; or in case of a company the main effort is to secure as large revenues as possible. In either case the highest relative rates will generally be collected along the line of least resistance.

We sincerely hope that the rates presented in the MANUAL OF AMERICAN WATER-WORKS for 1890 will aid in bringing about the reforms so much needed in this connection.

CORRESPONDENCE.

The University of Pennsylvania Prizes.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Feb. 1 last you published an article as to prizes offered by the University of Pennsylvania for papers on roads. The awards were to be made about May 5. I wrote a paper on the subject, and having heard nothing of the results up to the middle of July, I asked a friend in Philadelphia to find out for me what had been done. He finally learned that the committee had been unable to come to any decision before some of the members had to leave for Europe, and that the meetings stand adjourned till Oct. 10 next. If you could find room to give brief notice of this adjournment in your next issue you would doubtless relieve the minds of a good many competitors.

Clay under Telford Roads.

ELIZABETH, N. J. Aug. 10, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR:—In the building of a Telford road, the contractor has been permitted to substitute a layer of loamy clay about 3 ins. thick, as a binding for the foundation, and bedding for the first course of macadam, in place of a thin coating of 2-in. macadam, mixed with dry traprock screenings and compactly rolled, as called for in the original specifications prepared by the engineer. Is this a disadvantage to the permanency of the work or not?

INSPECTOR.

[It is a great disadvantage.—ED. ENG. NEWS.]

A New Lever Connecting Rod.

PARIS, July 25, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: We understand that there is a certain prize to be given by the United States Government for the best machine, or any part of a machine, which increases the power by a certain percentage without increasing the fuel consumption. As we are the patentees of a lever connecting rod which we claim is giving greatly more effective energy when substituted for the old form, we respectfully beg from your kindness to let us know all the particulars of such prize, if any. Hoping you will send soon an answer, E. PRENVEILLE.

[The United States Government rarely, if ever, offers such prizes, and there is no such prize now open. If our correspondent's device is to obtain financial recognition in this country it must be from purchasers of it in the open market.—ED. ENG. NEWS.]

The Late John Howden.

SAN FRANCISCO, Cal., Aug. 2, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: On May 19 last JOHN HOWDEN, foreman in the construction of the new bridge across Russian River at Duncan's Mills, Sonoma Co., California, met with a terrible accident. As was his wont, he was doing work that his men could have done, but which he thought he could do himself in less time than it would take to give the necessary instructions. Standing on the edge of a pier with a crow-bar, he was prying into place a stringer for the track, when the crow-bar slipped and he fell backward a depth of 22 ft. on hard excavated ground, breaking his back at the seventh vertebra. Regaining consciousness half an hour afterward, he asked what was the matter, and on being told that he had fallen he said: "Well, if some one had to fall, I would prefer it should have been I. When examined by a surgeon it was found that there was complete loss of sensation below the injury; the sphincters were paralyzed, and Mr. HOWDEN remained in a most miserable and precarious condition until the surgeon three days later cut down to the broken bone and removed it. This undoubtedly prolonged his life, but he finally succumbed to his injuries, and died on July 21, at the age of 50 years.

JOHN HOWDEN was in many respects an ideal foreman. Most careful for the safety of his men, he always undertook the most dangerous work himself, and he never expected his workman to do what he could not do himself. His courtesy and energy secured that respect from his men which guarantees a willingness and readiness to carry out his instructions to the full. Conscientiousness in his work made that work satisfactory to all concerned, and stimulated his men to be equally conscientious in theirs. In sickness or in accidents his men would go to him, and if he could not always relieve them of their pain, he did make it easier to bear.

After WORDSWORTH, his men can say:

He lived unknown, and few could know
When HOWDEN ceased to be;
But he is in his grave, and oh,
The difference to me! A. D. O.

Laying Out Race Tracks.

PHILADELPHIA, PA., July 28, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Will you kindly give your readers the facts of interest to engineers about race tracks; no work that I am acquainted with gives any direct information nor have your columns aided much.

What are the best dimensions for ½, ¾, and mile tracks, or what proportion of curve to tangent gives the "fastest" track? Are parabolic curves faster than simple curves? Are the above points the same for running and trotting tracks? Is a level track "faster" for running than a rising back stretch and falling home stretch, say 1 in. per 100 ft.? If a parabolic curve is used, what is the best way to locate the eighths or quarters? What is the

best distance to set the finish post from the P. C. of the curve? In building a track how near the grade may sand, clay or other poor material be permitted? Should carting or rolling on the grade be allowed, or back-fill by hand? A patented process of building tracks, sets turf blocks on edge and covers with loam for elasticity: would you infer that vegetable fiber, roots of grass, weeds, etc., would answer a like purpose, and what thickness and where would you place such material? Is it not better to try for a hard surface, and depend on the water-cart, rather than a moderately loose surface which might be hard to dry? Have tan or clay tracks, any advocates? How far from the fence is the track measured, and how high is the fence, and should a base board on fence be used in leveling? What is the best position for the grand stand, how far from the fence, and how much flare from parallel? What is the best width on curves, and elevation for 36 miles per hour, width on home and back stretch? What slope from center to fences, etc. The whole subject, track, grand stand, judges, weighing, betting ring, paddock and sheds would make an interesting paper.

M. S. MILLER.

[Our correspondent asks far too many conundrums for us. In the last three or four issues we have given considerable information in regard to race tracks, but there is undoubtedly still room for an interesting paper on the subject, and we should be glad to publish such if written from knowledge, and not by evolution from inner consciousness. —ED. ENG. NEWS.]

Engineering Interests in the United States of Columbia.

BOGOTA, U. S. Col., July 10, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: There is, during the session of Congress commencing July 20, a probability of a railway boom in this country. It is likely that a concession will be granted for a road from Bogota to the Magdalena River, at or below Honda. Parties are on their way here to negotiate for the reconstruction and extension of the Cauca Railway from Buenaventura (Pacific coast) to Cali; the government of Anticoquia has reconstructed and reopened their road from Puerto Berrio to Pavas, and will either make a contract to extend it to Medellin or do it themselves. It also begins to look as though the Cartagena-Calamar road would be built. This road will kill the Barranquilla (English) road, and will, no doubt, carry all the freight for the interior; provided, however, that the Santa Marta Railway does not touch the Magdalena above Calamar, in which latter case the traffic would be divided. The construction of the Giradot-Bogota road is progressing slowly. The possibilities of railroads here may be learned from the fact that the Bogota-Facatativa (Savanna) road earned $144,000 for passengers and telegraph only during the last ten months. The tramway of Bogota is now being repaired and extended, and will in a short time be in good running order. The government is carrying on improvements in connection with the navigation of the Magdalena. Last month dredging excavation to the amount of 10,000 cu. yds. was done in the Caño (an inlet from the river, through which steamboats reach the city) of Barranquilla at a cost of 15 cts. per cu. yd., pretty fair work for the tropics and a clamshell excavator.

My ideas of the Cartagena-Calamar road have changed, as I have had a chance to look into it more thoroughly. Before I accepted the statements of the Vice-Consul at Barranquilla, and the report of Mr CISNEROS, but since then (see Consular reports of February, 1890), I think a better way of answering would be to give an offset by the following figures:

Cost of construction, Cartagena to Calamar, 80 miles, at $15,000		$1,200,000
Actual or net operating expenses at $500 per mile per year	$40,000	
Interest on $1,200,000 at 6%	72,000	
Gross expenses	$112,000	
Freights, 47,500 tons at $2.30 per ton	$109,250	
Passengers per year (very low estimate)	3,000	
Receipts without considering local traffic	$112,250	

The road can be built with this amount, and there is no reason why a road, with good alignment and easy grades (which the Barranquilla road has not) and with good modern equipment (that of the other is antediluvian) and the advantage of a good harbor, would not carry all the freight now carried by the other. But if the government will let the mouth of the river be opened (politics interferes in favor of Cartagena), none of the three roads on the coast will amount to anything, as steamers could then go above Calamar.

Lieut. NAPOLEON B. WYSE is now here (just arrived) to try to make some arrangement for the Panama Canal. I do not think that this government will be as liberal as formerly in regard to that work. There is a great deal of interest here in the International Railway scheme, but I must confess that I am among the "doubting Thomases." Such a project is a little too vast for a century to come.

JAMES T. MCGAURAZ,
Engr. in Chief, Canalization Magdalena River.

The Michigan Engineering Society and Affiliation.

CLIMAX, Mich., July 31, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I notice in your issue of July 26 articles relative to affiliation of local engineering societies with the American Society of Civil Engineers. The Michigan Engineering Society was one of those honored with an invitation to consider the subject and suggest plans. The communications came, unfortunately, too late for the general meeting of the society. So far as I have been able to learn, the members of the Michigan Engineering Society fully appreciate the honor of an invitation to become affiliated with the American Society. The individuals with whom I have conversed, however, raise these questions as a preliminary to be settled before they are prepared to say whether they desire such affiliation or not. What is to be our standing with relation to the American Society? Are we to be full-fledged members, each man taking the position and standing to which his abilities and experience entitle him, or shall we be a sort of undergraduate country protégés of the great society, to be looked down upon and tolerated in subordinate positions only? What is to be the effect upon the local society? Will it be raised and helped by the affiliation? Will our publications be improved by it, and shall we get a better return for the time, brains and money we expend for our society, or will the American Society take the cream of our work and leave us the skimmings? What is to be the cost of the affiliation, and what are to be the returns?

The Michigan Engineering Society is doing a work suited to the wants of its members and the locality in which it is situated. The members are scattered over this and adjoining States. Only one general meeting is held each year. The members then meet as friends and acquaintances and discuss the subjects in which they are interested. Their principal expense is the cost of attending the annual convention. Every other expense is more than returned to them in the value of engineering literature furnished at cost price. The meetings are entirely devoted to work. Sight-seeing is done by individual members outside the time of the regular meetings. The society has become a recognized power, whose influence is felt far beyond the State limits. Mr. BOLLER'S statement that almost all the local engineering societies derive what standing they have from those members who belong to the American Society, without whom the local society could not live, does not apply to the Michigan Engineering Society, and probably not to any of the other societies which are recognized as State societies. So far as the Michigan Engineering Society is concerned, it is highly probable that its active members who belong to the American Society could not be relied on to even attempt such a stampede as Mr. BOLLER suggests. So far as I have been able to gather the sentiments of the members, they have at present no opinion for or against affiliation. Any future opinion will be based entirely on the terms decided upon. As there has been no opportunity for discussing or suggesting terms, for reasons already given, there is nothing to offer in that line; hence we simply await developments.

F. HODGMAN, Secretary M. E. S.

Strains in Curved Dams.

LONDON, July 19, 1890.

TO THE EDITOR OF ENGINEERING NEWS.

SIR: You have given so much attention to the question of curved dams in your columns that perhaps the following investigation of the strength of a circular caisson completely surrounded by water, and securely united at the bottom with the foundation, may be of some interest, as bearing on this interesting problem. Such a dam or caisson must from symmetry remain circular after deflection, which, of course, is not true where a dam abuts on the sides of a valley. But if the angle subtended by the dam is large this will not greatly effect the question, and hence, for such cases, the following formula should be fairly well applicable:

Taking first the simplest possible case of a dam of uniform section, then the water pressure is resisted partly by a ring pressure, which may be considered at least approximately as distributed in the same way as the pressures in a thick, hollow cylinder, with open ends.

Take a ring of the dam of unit height, and let T be the amount of the ring pressure. Then it is easy to see that this pressure T would support a pressure on the outside of the dam $= \frac{T}{r}$ where r is the radius. And owing to the "encastrément," or anchoring of the dam, this amount will be less than the water pressure P. The difference between these, viz. $\left(P - \frac{T}{r}\right)$ is the load causing bending of the dam in a vertical plane.

Now, if y be the bending moment at any point on a vertical strip, say 1 ft. wide, we have the well-known expression $\frac{d^2y}{dx^2}$ = load causing bending $= P - \frac{T}{r}$, whence we can get T in terms of water pressure P and the differential coefficients of y, the bending moment.

We have further P at any depth $x = Gx$, where $G =$ the weight of a cubic foot of water.

Hence $$T = \left(r\,Gx - \frac{d^2y}{dx^2}\right).$$

Again, the shear at any point on the vertical strip will be $S = \frac{dy}{dx}$, another well-known expression.

Then, by the general principles of elastic equilibrium, the work done by the internal stresses on the above mentioned vertical strip must be as small as possible, consistent with resisting the loads.

Now, the work done by the moment y on a strip of height dx is, as is well known, $\frac{y^2}{2EI}dx$, and on the whole strip is $\frac{1}{2}\int_0^h \frac{y^2}{EI}dx$ where E = elastic modulus, and I the moment of inertia of section.

Similarly, the work done by the shearing stresses on the same strip is $\frac{5}{2}\frac{A}{OE}S^2\,dx$, where A = a coefficient depending on the form of the cross-section $= \frac{6}{5}$ nearly for the section considered, and O = area of this section.

Now $S = \frac{dy}{dx}$; hence work done on whole strip by shear $= 3\int_0^h \frac{\left(\frac{dx}{dy}\right)^2}{OE}dx$.

Finally, it is easy to show that the work done on the strip by T, if this stress is distributed as in a thick hollow cylinder exposed to external pressure $= \frac{tk}{2E}T^2\,dx$, where $k = \frac{2}{3} + \frac{2}{n^2-1}$, n being the ratio of the inner and outer radii of the dam, and t = the angle subtended by 1 ft. of the dam at the center; *i. e.*, $t = \frac{1}{r}$. Hence, substituting for T its value, $T = r\left(G\,x - \frac{d^2y}{dx^2}\right)$, we get for the total work done by all the stresses the expression:

$$U = \int_0^h \frac{1}{2E}\left\{\frac{y^2}{I} + \frac{6}{O}\left(\frac{dy}{dx}\right)^2 + k\,r\left(Gx - \frac{d^2y}{dx^2}\right)^2\right\}dx$$

and this must be made a minimum: or writing for the instant $\frac{dy}{dx}P_1 = \frac{d^2y}{dx^2} = q$. This reduces to the standard form employed in the calculus of variations.

$$U = \int_0^h V\,dx = \int_0^h \frac{1}{2E}\left\{\frac{y^2}{I} + \frac{6}{O}p^2 + k\,r(Gx - q)^2\right\}dx.$$

Applying the methods of this calculus to the problem of making U a minimum, we get finally the following differential equation for y, viz.:

$$\frac{y}{I} - \frac{6}{O}\frac{d^2y}{dx^2} + k\,r\,\frac{d^4y}{dx^4} = o.$$

The solution of this equation can be very easily obtained, since $\frac{1}{I}$, $\frac{6}{O}$, and $k\,r$ are constants, in the form

$$y = A_1e^{m_1x} + A_2e^{m_2x} + A_3e^{m_3x} + A_4\,e^{m_4x}$$

where A_1, A_2, A_3 and A_4 are co-efficients which can be determined from the following relations, which are obtained as the subsidiary equations in deducing the differential equation, viz.:

(1) $y = o$ when $x = o$; *i. e.*, the bending moment is *nil* at the water level.

(2) $\frac{dy}{dx} = o$ when $x = o$; *i. e.*, the shear is zero at the water level.

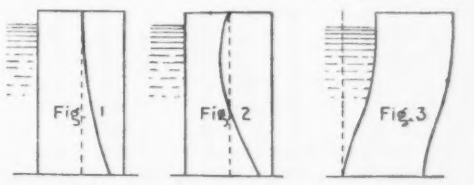
(3) $\frac{d^2y}{dx^2} = G\,h$ when $x = h$; *i. e.*, the arch pressure vanishes at the bottom of the dam, and

(4) $\frac{6}{O}\frac{dy}{dx} - k\,r\left(\frac{d^3y}{dx^3} - G\right)$ when $x = h$.

The physical interpretation of this last is not clear; m_1, m_2, m_3, and m_4 are, of course, the roots of the equation

$$\frac{1}{I} - \frac{6}{O}m^2 + kr\,m^4 = o$$

If the above values of the A's and the m's are determined, it will be found that the bending moment curve has the form shown in Fig. 2, the form for a straight dam being that shown in Fig. 1. Further, the deflection of the dam will not be a maximum at the top, but at a point some distance down, as indicated in Fig. 3.



The case of a dam of variable section is more complicated, but by expressing $\frac{1}{I}$ $\frac{6}{O}$ and kr as functions of x, the following differential equation giving the bending moment may be obtained.

$$\frac{y}{I}\cdot\frac{d}{dx}\cdot\frac{6}{O}\cdot\frac{dy}{dx}+\frac{d^2}{dx^2}kr\left(\frac{d^2y}{dx^2}-Gx\right)=o$$

With similar conditions as before to determine the arbitrary constants A_1, A_2, A_3 and A_4. The solution of this can usually only be found in the form of an infinite series. H. M. M.

A New Substitute for Asphalt.

Germany possesses no quarries of bituminous limestone suitable for street pavements. The chemists of that country have often tried to find an artificial substitute, but never succeeded. The compositions lacked the necessary strength and elasticity, although every possible combination of limestone and bitumen was tried.

Herr BUSSE, a chemist of Linden, near Hanover, noticed that all artificial asphalts lacked certain gummy oils existing in the natural stone. This led him to experiment on mixtures of finely powdered stone with these oils, with the result of producing a material said to be very similar to natural asphalt.

The material is claimed to be absolutely impervious to the action of the weather. At the government testing bureau at Charlottenburg the compressive strength was found to be about 2,300 lbs. per sq. in. In some experiments in Hanover it was found that a layer of the material 2 ins. thick would stand a pressure of 5,970 lbs. per sq. in. The difference between this figure and that just given is probably due to the fact that the government tests were made on centimetre cubes. About 500 sq. yds. were laid in Hanover in the summer of 1887; this surface has worn so well that 1,670 sq. yds. are now being laid in that city. Berlin, Hamburg and Cologne have begun series of tests also.

The compound is laid in a similar manner to asphalt. For streets, a concrete foundation 8 ins. thick is laid, and on this enough of the hot powder is spread to leave a 2-in. layer when well rolled.

The cost of this pavement is not given, and, as the *Schweizerische Bauzeitung*, to which we are indebted for these notes, states the new invention must not only be as serviceable but also as cheap as the natural asphalts in order to compete with them.

The Examination of Water Supplies.

The importance of examining water supplies to determine their fitness for domestic purposes is slowly becoming apparent to the public. This is shown by the increasing number of samples of water sent to chemical laboratories for examination, and by the action of some of our State legislatures in providing for such examination by State boards of health. Generally, however, no examinations are made until an outbreak, say of typhoid fever, leads local physicians to suspect that the drinking water is impure.

This subject is discussed by Prof. V. C. VAUGHAN in *The Technic* for 1890, an annual published by the Engineering Society of the University of Michigan. Prof. VAUGHAN first calls attention to the decrease in deaths from typhoid fever in Munich and Vienna since the introduction of good sewerage and waterworks systems, and to the present low death rate from this disease in Brooklyn and New York. In 1849 the death rate from typhoid fever in Munich was 24.6 per 10,000 inhabitants, while in 1884 it had been reduced to 0.5 per 10,000. In New York the death rate from the same disease is 2 and in Brooklyn but 1.5 per 10,000 inhabitants, while the average rate for the United States is about 6.6.

There occur each year in the United States about 40,000 deaths from typhoid fever and 360,000 additional cases which do not prove fatal. The average value to the State of an adult life is placed at $1,000; so we have an annual loss, says Prof. VAUGHAN, of $40,000,000 from such deaths done. There is an error in these figures, for not all who die from this disease are adults, but allowance should also be made for cost of medical and other attendance during sickness, for funeral expenses, and for all the expense of the sickness of the 360,000 who recover, and the loss of their labor while sick.

Pure air, water and soil would practically do away with typhoid fever, and would largely reduce the sickness and death resulting from other contagious diseases. In nearly all of the smaller towns and throughout the whole of the sparsely settled parts of the country an impure soil means an impure supply of water, and therefore the importance of careful examinations of the latter.

How rapidly the soil may be contaminated is expressed by Prof. VAUGHAN in the following words:

The excretions from a family of six persons are sufficient when dissolved to saturate over 7 cu. ft. of gravel soil. From this it is evident that only a few weeks, or months at most, would suffice, with a proper amount of rainfall, to saturate every cubic foot of soil to a depth of 5 or 10 ft. in a small yard in which we often find privy-vault, cesspool and cistern or well in close proximity. At this rate it would require more than a few feet, or even rods, of intervening soil to prevent the contamination of the water of wells or leaky cisterns from privy-vaults, which often are not cleaned once a year, or from cesspools or cemeteries.

The last part of Prof. VAUGHAN'S article outlines a plan for examining water and gives a copy of a blank used in reporting on the same. In substance it is as follows:

The sanitary examination of water should be both chemical and bacteriological. The following I regard as necessary conditions of all such examinations.

(1) The report must be made to the health officer within a week, at most. Typhoid fever appears in a village. The doctor at once suspects the drinking water. He naturally weighs the evidence before him, and comes to some conclusion, right or wrong, in case there are several sources from which the sick may have obtained the poison, as to the exact water which is at fault.

The health officer sends to the laboratory one or more samples of water, and the report is anxiously looked for. We therefore regard all methods of water analysis which require more than a week at most before the health officer receives his return as not suitable for our purposes. For this reason we have been compelled to give up the idea, with which we started out, of identifying positively and certainly all the germs which might be present in the water, before reporting to the health officer.

(2) If the water is bad, the fact should be so plainly and forcibly set forth in the report that no reasonable person can question it. It can hardly be expected that a chemical analysis alone will do this.

(3) The reports should be made in such a manner that they will be of scientific as well as practical value. After several years of such work we hope to have a mass of evidence in these reports which may furnish us the key to certain problems which to-day cannot be solved.

(4) When the report is made, the work with that sample of water should be left in such a condition that for strictly scientific purposes it can be continued.

The method of procedure pursued in the hygienic laboratory of the University of Michigan is as follows:

If a health officer or other person has signified his intention of sending a sample of water, we express to him a one-gallon sterilized glass-stoppered bottle surrounded by a light wooden frame. This is filled with the water and returned. As soon as it reaches the laboratory, gelatine plates are made, and a tube of sterilized beef-tea is inoculated with one drop of the water. The plates are kept at the ordinary temperature of the room, and the germs developed on these are counted after 24, 48 and 72 hours. The tube of beef-tea is placed in an incubator and kept at 38° C. for 24 hours, after which an animal is inoculated. In the great majority of cases, if there are poison-producing germs present, the animal dies within 12 hours. The post-mortem is made and plates inoculated from the liver, spleen, kidney, and sometimes other organs. Within 36 hours more the germs on these plates have developed. In the meantime the chemical and microscopical examinations have been made, and 72 hours after the water has been received the report is complete.

The morphology, the physiology, and the chemistry of the micro-organisms can then be worked out at leisure.

The following is a copy [in substance] of the blank used for making the report:

PHYSICAL PROPERTIES.

Color, odor, reaction, hardness.

CHEMICAL ANALYSIS.

Parts per Million.

(1) Total residue obtained by evaporation at 110° C. (2) Residue after ignition, or inorganic matter in residue. (3) Organic residue, or loss on ignition. (4) Amount of earthy bases, calculated as oxides. (5) Amount of chlorine, calculated as sodium chloride. (6) Amount of sulphates calculated as SO_3. (7) Parts of potassium permanganate reduced by the organic matter in the water. (8) Amount of free ammonia. (9) Amount of albuminoid ammonia. (10) Amount of nitrates, calculated as N_2O_5. (11) Amount of nitrites, calculated as N_2O_3.

Explanation.

While no absolute standard for the chemical purity of drinking water can be given, the following conclusions may be regarded as approximately correct:

(1) The total residue should not exceed 500 parts per million.

(2) The inorganic residue may constitute the total residue.

(5) The smaller the amount of organic residue, the better the water.

(4) The amount of earthy bases should not exceed 200 parts per million.

(5) The amount of sodium chloride should not exceed 10 parts per million. A larger amount may be expected, however, in certain salt-producing districts.

(6) The amount of sulphates should not exceed 100 parts per million.

(7) The organic matter in one million parts of the water should not reduce more than 8 parts of potassium permanganate.

(8) The amount of free ammonia should not exceed 0.05 part per million.

(9) The amount of albuminoid ammonia should not exceed 0.15 part per million.

(10) The amount of nitric acid should not exceed 0.05 part per million.

(11) The best waters contain no nitrous acid, and any water which contains this substance in quantity sufficient to be estimated should not be regarded as a safe drinking water.

MICROSCOPICAL EXAMINATION.

(1) Description of deposit, if any, magnified 100 diameters.
(2) Same magnified 500 diameters.

Explanation.

Six ounces of the water are placed in a conical glass, and the deposit, if any, is examined after from 12 to 24 hours. The presence of any appreciable deposit, especially if it be of animal or vegetable nature, would detract from the suitability of the water.

BACTERIOLOGICAL EXAMINATION.

Number of germs developed on a gelatine plate inoculated with one drop of water:
(1) After 24 hours. (2) After 48 hours. (3) After 72 hours.
Remarks on the kinds of germs observed:

INOCULATION EXPERIMENTS.

Kind of animal inoculated with the germs.—Method of inoculation.—Kind, amount and age of culture used.—Results of the inoculation.—Post-mortem appearances.—Description of the germs, if any, found in the organs.—In what organs were the germs, if any, found growing.

Explanation.

One drop of water is added to one drachm of some culture medium, such as beef tea, and this, after it has been kept at the temperature of the body for 24 hours or longer, is used for inoculating animals.
[Conclusions, signature and date follow.]

SAMPLES OF DRINKING WATER EXAMINED IN THE HYGIENIC LABORATORY OF MICHIGAN UNIVERSITY, FROM OCT. 1, 1888, TO MAY 1, 1890.

No.	Water from.	Kind.	Free ammonia.	Albuminoid ammonia.	Chlorine.	No. of germs.†
			Parts to the million.			
1	Omaha, Nebraska.	Well	0.168	0.118*	129.0	50
2	" "	"	0.050*	0.124*	97 0	46
3	" "	"	0.664	0.230	12.0	120
4	" "	"	0.162	0.116*	45.0	50
5	" "	"	0.094	0.112*	23.0	26
6	" "	"	0.028*	0.090*	34.0	18
7	" "	"	0.022*	0.102*	48.0	38
8	" "	"	0.172	0.088*	48.0	36
9	" "	"	0 054	0.068*	98.0	20
10	" "	"	0.032*	0.096*	8.0*	8
11	Coldwater, Mich.	"	0.270	0.045*	8.0*	500
12	" "	"	0.015*	0.025*	14 0	712
13	" "	"	0.270	0.040*	15.0	370
14	" "	"	0.025*	0.040*	12.0	580
15	Ida, "	"	0.910	0.120*	155.0	2,000
16	Brown City "	"	0.220	0.096*	8.0*	400
17	Kalamazoo, "	"	0.041*	0.084*	7.0*	63
18	" "	"	0.020*	0.066*	7.0*	60
19	Mt. Pleasant, "	River	0.094	0.208	79.0	3,000
20	Gambier, Ohio.	Well	0.065	0.062*	240.0	683
21	Azlegan, Mich.	"	0 206	0.148*	33.0	300
22	Three Rivers, "	"	0.070	0.046*	9.0*	25
23	" "	"	0 108	0.072*	7.0*	20
24	" "	"	0.024*	0.054*	7.0*	22
25	Allegan, "	Hydrant	0.220	0.066*	31.0	40
26	" "	Artesian	0.272	0.056*	32.0	25
27	Coldwater, "	Well	0.025*	0.038*	14.0	16
28	Kalamazoo, "	"	0.144	0.058*	9.0*	280
29	Tecumseh, "	"	0.037*	0.078*	10.0*	40
30	Ishpeming, "	Lake	0.222	0.418	6.0*	455
31	" "	"	0.036*	0.222	2.0*	50
32	" "	"	0.038*	0.208	3.0*	48
33	Three Rivers, "	Well	0.200	0.036*	0.9*	30
34	" "	"	0.060	0.102*	0.7*	25
35	" "	"	0.016*	0.062*	1.0*	22
36	St. Louis, "	Reservoir	0.050	0.210	23.0	8,400
37	" "	Pine River	0.044*	0.320	24.0	1,008
38	Climax, "	Well	0.006*	0.084*	4 5*	105
39	Grand Rapids, "	River	0.030*	0.134*	10.0*	36,000
40	" "	"	0.024*	0.075*	6.0*	120
41	Ann Arbor, "	Cistern	2-223	0.908	3.0*	3,000
42	Negaunee, "	Lake Teal.	0.228	0.368	30.0	920
43	" "	"	0.232	0.460	30.0	1,210
44	" "	"	0.296	0.448	40.0	772
45	" "	Mine	0.312	0.236	140 0	2,060
46	" "	Sand shaft	0.042*	0.120*	40.0	772
47	Mendon, "	Well	0.019*	0.048*	4.0*	25
48	" "	"	0.020*	0.210	34.0	100
49	Deerfield, "	"	0.508	0.158	695.0	898
50	Northville, "	"	1.136	0.732	6.7*	1,550
51	Iron Mount'n, "	"	1.256	1.920	44.0	1,500
52	" "	"	0.384	0.840	20.0	1,350
53	" "	"	0.784	0.960	52.0	1,260
54	" "	"	0.904	1.360	16.0	1,700
55	" "	"	0.456	0.944	12.0	850
56	" "	"	0.404	1.256	28.0	950
57	Ann Arbor, "	Cistern	0.318	0.262	6.0*	1,200
58	" "	"	0.492	0.504	9 0*	1,770
59	Rankine, Ill.	Well	3.512	0.332	24.0	738
60	Pomfret, Conn.	"	0.104	0.116*	4.0*	151
61	Sherwood, Mich.	"	0.194	1.160	7.0*	4,116
62	Soudan, Minn.	Lake	0.144	0.488	3.0*	428
63	" "	"	0.132	0.488	4.0*	459
64	" "	Well	0.120	0.090*	2.0*	28
65	" "	"	0.072	0.124*	2.0*	4
66	Lake City, Mich.	Lake	0.154	0.280	3.0*	124
67	Iron Mount'n, "	"	0.260	0.270	4.5*	9
68	Ironwood, "	Well	0.176	0.248	9.9*	12
69	Ann Arbor, "	Spring	0.012*	0.016*	2.5*	0
70	" "	"	0.044*	0.120*	4.0*	4
71	" "	"	0.050*	0.080*	6.0*	0
72	" "	"	0.090	0.214	4 0*	6
73	Leslie, "	Well	0.536	0.840	14.0	104
74	" "	"	1.144	0.984	12.5	2,940
75	Ann Arbor, "	"	0.064	0.064*	17.0	150
76	" "	"	0.070	0.070*	6.0*	60
77	" "	Spring.	0.194	0.194	3.5*	295

*Not in excess of allowable quantity, as given in the text.

† Developed on gelatine plate inoculated with one drop of water.

The above table of examinations, though not very extended, is instructive. It shows that of 77 samples examined, all but 13 contained an excessive

amount of the three chemical substances included in the table, and all but two contained bacteria. There was an excess of free ammonia in 53, of albuminoid ammonia in 34, and chlorine in 38 of the 77 samples analyzed.

Of the 13 samples not having an excess of any of the three substances, eight were from wells, three from springs, and two from a river; two of them were without germs, while one developed 36,000, the most in any of the samples, by inoculating a gelatine plate with one drop of the water. This last was taken from the river at Grand Rapids Mich.

Some sort of small animal was inoculated with the germs found in the various samples analyzed, but in eighteen of the cases the inoculation was without effect. The samples containing germs causing death were Nos. 39, 41-45, inclusive, 51-59, inclusive, 62 and 65.

It is a striking fact that all the germs causing death were found in the last half of the samples analyzed, and also that more of these samples show an excess of ammonia, albuminoid ammonia and chlorine than in the first half. As the samples are merely numbered, the time of their selection and its consequent effect cannot be commented upon, a fact which we regret.

The Nicaragua Canal Traffic.

An important feature in regard to the Nicaragua Canal traffic, and its probable effect to stimulate American commerce, is thus noted in a recent article in the New York *Times*:

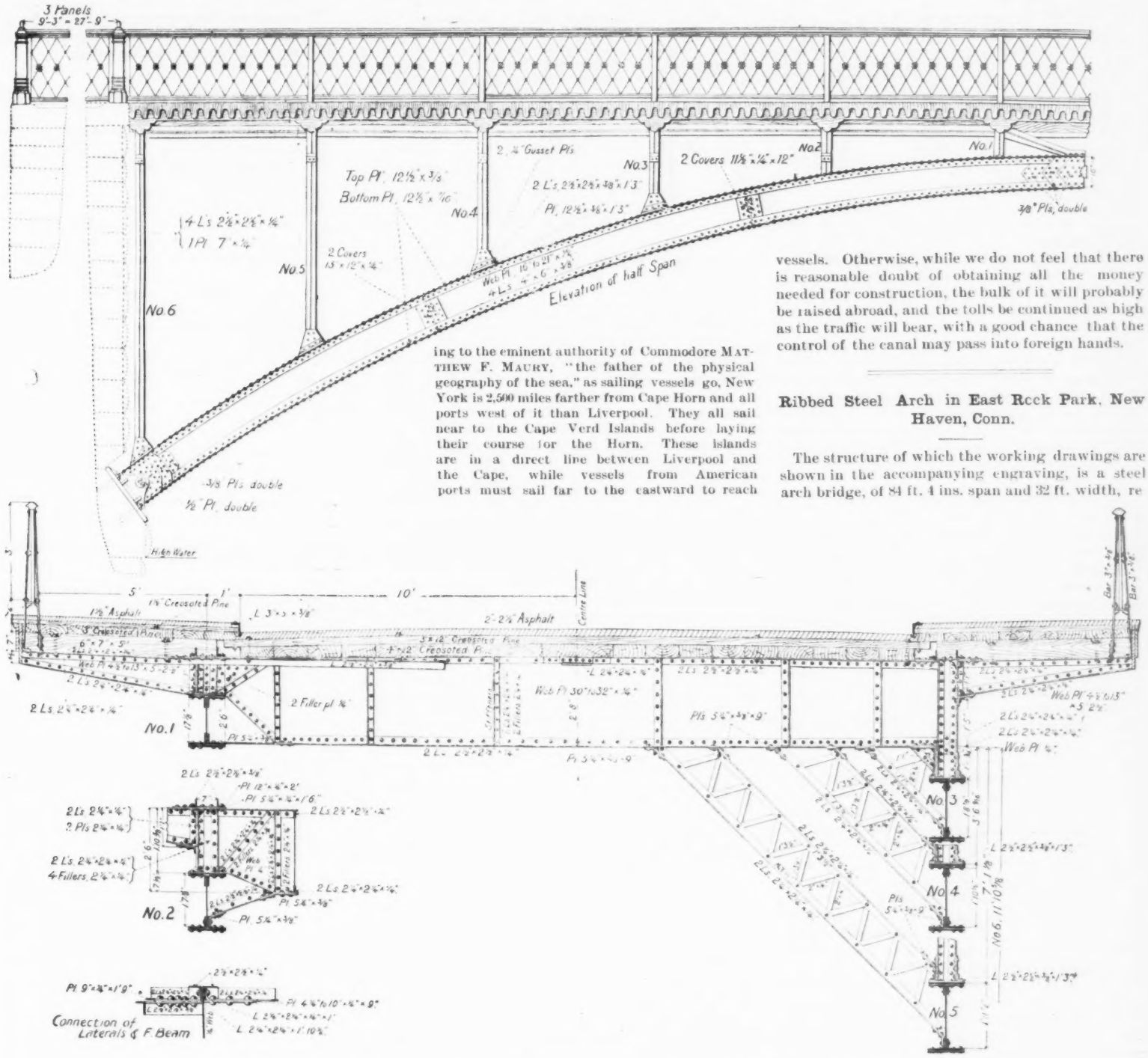
The effect of the canal upon our merchant marine could not fail to be of the most important character. It would afford opportunity for the employment of all classes of shipping along a coast line extending from Maine to Alaska, in which traffic foreign vessels would be unable to compete. It would also work a revolutionary change in the respective opportunities of our own Atlantic ports and those of Europe in their relation to trade to the Pacific Ocean. A map of the world shows New York and Liverpool to be nearly equidistant from Cape Horn, but according to the eminent authority of Commodore MATTHEW F. MAURY, "the father of the physical geography of the sea," as sailing vessels go, New York is 2,500 miles farther from Cape Horn and all ports west of it than Liverpool. They all sail near to the Cape Verd Islands before laying their course for the Horn. These islands are in a direct line between Liverpool and the Cape, while vessels from American ports must sail far to the eastward to reach them. Therefore a sailing ship bound from Liverpool around Cape Horn has an advantage of 2,500 miles in distance over a New York ship for the same destination.

But by the canal, while Liverpool would be within 7,500 miles of San Francisco, saving 7,000 miles over the Cape route, New York would be within 4,700 miles, and not only save 10,000 miles of actual distance, but also 2,500 miles which her ships now lose in going to the eastward. In other words, instead of having 2,500 miles more to sail, the New York ship would have 2,700 miles less than the Liverpool ship, or a gain of 5,200 miles. The saving by the canal between ports near its western outlet and our ports on the Gulf and the Atlantic would be so great that it could scarcely fail to result in turning the trade of those ports, which now goes to Europe into our markets. Callao and Valparaiso would be respectively 3,000 and 4,000 miles from New Orleans and 6,400 and 7,400 miles from Liverpool by way of the canal. It would be strange, indeed, if such a reversal of existing conditions should not result in breaking down the artificial trade routes and relations which now exist and turning the commerce of these neighboring countries into more convenient and natural channels.

For many reasons the work seems to be one of great national importance, and it appears to us that it would be eminently wise for Congress to ensure its early construction and continued American control by guaranteeing its bonds and exacting in return certain conditions as to tolls, especially on American vessels. Otherwise, while we do not feel that there is reasonable doubt of obtaining all the money needed for construction, the bulk of it will probably be raised abroad, and the tolls be continued as high as the traffic will bear, with a good chance that the control of the canal may pass into foreign hands.

Ribbed Steel Arch in East Rock Park, New Haven, Conn.

The structure of which the working drawings are shown in the accompanying engraving, is a steel arch bridge, of 84 ft. 4 ins. span and 32 ft. width, recently built at New Haven, Conn., under direction of City Engineer ALBERT B. HILL.


3 Panels 9'-3" = 27'-9"
Top Pl. 12½" x ⅜"
Bottom Pl. 12½" x 7/16"
4 L's 2½" x 2½" x ¼"
1 Pl. 7" x ¼"
2 Covers 13" x 12" x ¼"
2-4" Gusset Pls
2 L's 2½" x 2½" x 48" x 13"
Pl. 12½" x ⅜" x 13"
2 Covers 11½" x ¼" x 12"
⅜" Pls, double
No. 1
No. 2
No. 3
No. 4
No. 5
No. 6
Elevation of half Span
⅜" Pls double
½" Pl. double
High Water
1½" Asphalt
1½" Creosoted Pine
2-2½" Asphalt
Centre Line
3" x 12" Creosoted Pine
4" x 12" Creosoted Pl.
2 Filler pl ⅜"
Web Pl 30" x 32" x ⅜"
Pls 5¾" x ⅜" x 9"
2 L's 2½" x 2½" x ⅜"
2 Pls 2¾" x ⅜"
4 Fillers 2¾" x ⅜"
Pl 12" x ⅜" x 2'
Pl 5¾" x ⅜" x 1'6"
Web Pl ⅜"
Fillers 2¾" x ⅜"
Pl 9" x ⅜" x 1'9"
Connection of Laterals & F. Beam
Web Pl ⅜" x 13"
Web Pl ⅜"
Pls 5¾" x ⅜" x 9"

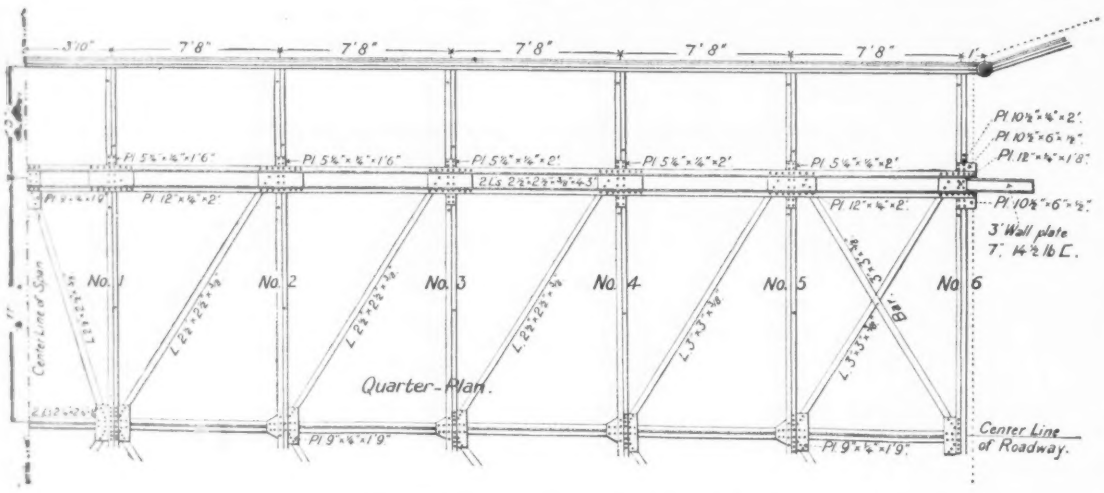
RIBBED STEEL ARCH AT ROCK LANE, NEW HAVEN, CONN.—ALBERT B. HILL, ENGINEER.

The abutment on one side of the river rests on hard gravel, on the opposite side on pile and grillage foundations, the piles driven through a bed of quicksand. A bed of concrete was rammed in around the pile heads.

The superstructure is a three-hinged ribbed arch, 84 ft. 4 ins. span between end pin centers, and 14 ft. 3 ins. rise; the roadway is 20 ft. clear wide and the two sidewalks are each 6 ft. wide.

It is calculated to carry, besides its own weight, a

ive load of 100 lbs. per sq. ft. moving on from either end until the whole bridge is covered, or a concentrated load of 12 tons on four wheels 6 ft. apart transversely, and 8 ft. apart longitudinally, placed anywhere on the roadway. No spandrel bracing is used, but the arches themselves are calculated to resist the maximum stresses resulting from unsymmetrical loading. The stresses in the arch ribs were determined at each panel point and midway between each panel point for that condition of loading that would give the maximum stresses



QUARTER-PLAN OF ROCK LANE ARCH.

of tension and compression at that particular point. The curve of the top rib is a circular arc of 71 ft. radius. The bottom rib for each semi-arch has a radius of 73 ft. The depth of arch at springing is 20 ins.; at ⅙ distance from springing to crown, 21 ins.; at ⅓ the distance, 19½ ins., and at the crown, 16 ins. The ribs contain a little surplus metal at springing and crown.

There is no diagonal bracing at the end panels. The stresses in lateral bracing, which are angles, are taken at channels anchored in the masonry at the floor level, and resting between the pair of angles forming the top chord.

All the metal work is mild steel of 60,000 to 65,000 lbs. tensile strength, excepting the end shoes, which are cast iron. Specimens cut from plates and angles were required to bend cold 180° on a radius equal to their thickness without sign of fracture. The pins of the arch are 4⅞ ins. diameter, pin-holes to be not more than 1/32 in. larger. Rivet holes 13/16 in. in diameter, and may be punched. Rivets, ¾ in., of tough steel with a strength of 50,000 to 55,000 lbs. The contract date for completion was May 15, proposals being closed on March 5.

The woodwork, paving and stone cutting were done by the city. The contract for the remainder of the work was let to the Berlin Iron Bridge Co. for $3,057, their bid being the lowest of 14 received.

The under floor is Southern pine, creosoted with 15 lbs. of dead oil of coal tar per cu. ft. of lumber. The bottom course, laid longitudinally, is 4 ins. thick on roadway, and 3 ins. thick on sidewalks. The top course, laid transversely and thoroughly spiked to bottom course, is 3 ins. thick on roadway and 1½ ins. thick on sidewalks. On the planking is tacked down a double thickness of tarred paper. On this is laid the wearing surface of 2½ ins. of asphalt on the roadway and 1½ ins. on sidewalks.

The substructure work was done by Robert Redfield & Sons, and cost $7,287.42. The creosoted pine was furnished by Eppinger & Russell. The asphalt paving was done by Charles W. Crockett.

The total cost of the bridge and a little filling on the approaches was $12,627.80, or nearly $150 per lineal ft. The bridge proves very rigid, and gives good satisfaction.

American Machinery at the Iron Gate on the Danube River.

The Ingersoll-Sergeant Rock Drill Co., of New York has received an order from the contractors engaged in removing the Iron Gate of the Danube River for a large plant of submarine drilling apparatus. Mr. BESSIER, a German engineer, recently visited this country, in the interests of the work on the Danube. He investigated thoroughly our American methods, and decided to adopt them as the best for the purpose. The work extends for 20 miles along the Danube River and will cost about $3,000,000.

The removal of these obstructions has been attempted many times; the emperor TRAJAN having been the first to enter on the work. The Austrian Government recently made a similar attempt, but without success. The present undertaking is under the direction of Herr HAIDU and the Brunswick, Germany, Machine Works. In this connection it is interesting to note that the European Danube Commission has decided upon a new cut in that river, by which the distance from Galatz to Sulina will be diminished by nearly five miles.

A FAST RUN is reported on the St. Louis division of the Cleveland, Cincinnati, Chicago & St. Louis. It is claimed that several miles were run at a speed of a mile in 46 seconds, or 78 miles per hour, and one mile was made in 41 seconds, or at the rate of 89 miles per hour. The train consisted of a 10-wheel engine, with 70-in. drivers, hauling six cars.

THE BLOCK SYSTEM is to be put in use on the New York, Pennsylvania & Ohio, between Kent and Galion, 92 miles. The blocks will be about five miles long. It is thought the system can be got ready for use in 60 days.

A BRIDGE near Caseville, Mich., fell under a traction engine Aug. 9. A dam at Franklin Falls, N. H., failed recently. The water made a passage around one end of the structure, and emptied a pond of 100 acres area. Mill ponds below were fortunately empty and the damage was slight. A bridge across the Platte river at Golden Ave., Denver, Col., has been washed away.

SEVERE STORMS have occurred in Northern Wisconsin, washing out the Wisconsin Central Ry. The Arizona washouts, noted last week, were so serious that no trains from the east entered Tucson for nearly a week.

ARANSAS PASS, on the Texas coast, is to be made a great commercial port, if the Aransas Harbor City and Improvement Co., just organized in Kansas, does all it plans to do. Congress has passed a bill giving the company the privilege of dredging and improving the harbor at this point to make its entrance passable for vessels of deep draft. The company has a year in which to begin the work and five years to complete it. RUSSELL HARRISON, of Helena, Mont., is President of the company.

SALT WATER IS USED FOR EXTINGUISHING FIRES on the water front at Seattle, W. T. The direct pressure system is used, and the pumps are located in an electric light company's station.

ELEMENTS OF WEATHER IN UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF JULY, 1890.
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

STATION.	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Maxim.	Direction at time of max. velocity.	Precipitation.—Rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.										
Northfield, Vt	62.6	89	38	51	8.1	44	W	2.87	.63	16
Portland, Me	67.4	93	51	42	7.2	28	S	3.58	1.43	7
New York City	73.4	95	56	39	9.0	34	NW	3.96	1 33	10
Pittsburg, Pa	74.0	94	53	41	2.9	19	S	2.22	.74	12
Chicago, Ill	72.1	93	56	37	15.5	52	NE	2.57	1.31	5
Omaha, Neb	78.8	105	55	50	8.5	28	S	3.74	2.97	8
St. Paul, Minn	71.9	94	51	43	7.0	25	SE	1.87	1.08	13
Duluth, Minn	66.3	92	48	44	6.3	36	NW	3.51	1.06	12
Bismarck, N. Dak	71.0	98	44	54	10.1	48	N	1.14	.68	7
Average	70.8	94.8	50.2	44.6	8.3	34.9	.....	2.83	1.25	10
SOUTHERN CITIES.										
Washington City	75 0	98	53	45	5.0	20	S	3.24	1.07	9
Louisville, Ky	78.3	96	59	37	5.6	32	W	2.05	1 73	5
St. Louis, Mo	79 8	98	57	41	9.9	37	SW	.37	0.14	4
Savannah, Ga	79.5	94	67	27	5.6	25	NE	7.72	2.08	18
Leavenworth, Kan	80.6	102	58	44	6.5	24	SW	1.61	0 86	9
Jacksonville, Fla	81.0	96	66	30	6.0	30	SE	9.70	2.45	24
Chattanooga, Tenn	78.8	95	64	31	4.5	36	E	4.43	2.88	16
New Orleans, La	81.6	96	68	28	6.0	42	N	6.59	1.67	15
Memphis, Tenn	81.0	98	64	34	5.4	40	SW	2.82	1.30	10
Palestine, Tex	82.0	97	66	31	4.0	24	NE	1.76	1.28	4
Average	79.8	97.0	62.2	34.8	5.8	31.0	.....	4 03	1 55	11.4
WESTERN CITIES.										
Helena, Mont	71.0	93	48	45	7.0	48	SW	0.58	0.18	8
Port Angeles, Wash	*	*	*	*	*	*	*	*	*	*
San Francisco, Cal	59.8	80	49	31	11.4	34	W	0.02	0.02	1
Salt Lake City, Utah	75.0	98	52	46	4.8	24	SE	0.02	0.02	1
Denver, Col	74.8	97	54	43	6.5	48	W	0.79	0.58	9
Yuma, Ariz	92.2	115	74	41	8.3	40	W	†	†	0
Santa Fé, N. Mex	69.8	90	48	42	6.2	30	NW	2.46	0.46	18
Average	77.1	95.5	54.2	41.3	7.7	37.3	.....	0.64	0.21	6.2

* Report not received. † Trace.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO—Existing Roads.

Rockaway Valley.—Capital has been secured for the extension of this New Jersey road from Peapack to Mendham. From the latter place the tracks will be extended to Morristown; J. E. V. Melick, White House, N. J., is Superintendent and Chief Engineer. New iron mines have been opened along the line, and the road is doing a profitable business.

Concord & Montreal.—A survey for a new line for the Concord & Portsmouth R. R., between Greenland and Epping, is in progress under Engineer Arthur Dudley, of Brentwood, N. H.

Baltimore & Delaware Bay.—It is stated that this short road in Kent Co., Md., will again become part of the system of the Central R. R., of New Jersey. It was found that the road could not pay expenses when operated separately.

Kilbuck Valley.—The city of Wooster, O., has voted $100,000 to complete this road.

Wabash.—Grading on the line which will connect the main line with the Eel River division will not be finished before Sept. 15.——It is again reported that this company has purchased the American Midland Ry. in Ohio.

Knox & Lincoln.—This Maine road has been sold to a syndicate headed by Payson Tucker, General Manager of the Maine Central system.

Detroit, Lansing & Northern.—An extension has been completed and opened for traffic from Rodney, Mich., to Chippewa Lake, 5 miles.

Delaware, Lackawanna & Western.—It is reported that surveys are in progress for a line from West Pittston, Pa., to Waverly, N. Y., paralleling the Lehigh Valley. It is said that the line would give a shorter route for the coal shipments to Buffalo, but the gain does not seem of enough importance to make probable the construction of the line.

Cincinnati, Saginaw & Mackinaw.—A short extension of about 5 miles is reported at West Bay City, Mich.

Pennsylvania.—It is stated that the scheme of elevating the tracks in the city of New Brunswick, N. J., has been given up for the present. The company will begin work at once, however, on the straightening of its road through the city.——Surveyors are at work on a line from Lebanon to Middletown, Pa., about 22 miles.——The Gould tunnel, 7 miles from Steubenville, O., is to be enlarged for a double track. The estimated cost will be about $150,000. A temporary line, 4 miles long, will be built for use while the tunnel is being enlarged.——It is stated that a contract has been let for a 40-mile extension from Bellaire to Marietta, O.

Western New York & Pennsylvania.—An extension 46 miles in length is contemplated, from Oil City, Pa., to some point on the New Cast e division. It is stated that President Allen's trip abroad is for the purpose of raising funds for this work.

Baltimore & Ohio.—The Baltimore Belt Ry. has been absorbed by this company and will be completed under its direction. Vice-President Thos. M. King will have general charge of the work of construction, and is now receiving bids from contractors. President Mayer is said to be negotiating for foreign capital for carrying out the work. At the meeting on Sept. 8, the stockholders will be asked to ratify the action of the President and Directors in this matter and in the lease of the Akron & Chicago Junction Ry.

Canadian Pacific.—A recent press rumor describes this company as urging the Boston & Maine to purchase the New York, Providence & Boston R. R. In this way both the Canadian Pacific and Boston & Maine would obtain an entrance to New York. ——An English syndicate is reported at work securing options on land for the site of a bridge across the Niagara river.

Philadelphia & Reading.—It is announced that the company has secured a favorable site on the Arthur Kill, near Perth Amboy, and will at once proceed with the erection of two large coal shipping piers, each extending out 700 ft. from the shore line. In the rear of the piers 24 storage tracks will be laid, each 2,000 to 4,000 ft. in length, and extensive facilities for the prompt and easy trans shipment of many other kinds of bulk freight will be put in. The estimated capacity of the new docks is 2,500,000 tons of coal per year. A new railway, 18 miles in length, will be built, extending from Bound Brook to the terminus above described. It will be built in the most substantial manner, with culverts and bridges for a double track line. The line will be laid at first with a single track (90 lbs. weight of rail), and as soon as completed, a construction train will be put on to widen the grade for a double track.——The Harrisburg Terminal and Harrisburg & Shippensburgh Ry. companies have been consolidated as the Philadelphia, Harrisburg & Pittsburg Company.——It is proposed to extend the short branch which now ends at Steelton, 3 miles south of Harrisburg, Pa., to Middletown, to connect with the Middletown & Hummelstown Ry.

Projects and Surveys.

Auburn, Leginier & Chicago,—This company has been organized in Indiana to build a railway from Auburn to Hammond, east and west nearly across the northern part of the State. The enterprise is furthered to induce the Wabash to take this route for its short cut to Chicago instead of the route from Montpelier.

Port Clinton Short Line.—E. H. Brennan, of Port Clinton, O., President of this company, is reported as saying that he is still working to enlist capital for the enterprise, and hopes to see it accomplished at an early day.

Washington & Cumberland.—This company, which proposes to build a railway along the towpath of the Chesapeake & Ohio Canal, is applying for right of way for an entrance to Washington, D. C.

Cobourg, Cumberland & Pacific.—At a recent meeting of the stockholders of this company at Cobourg, Ont., Robert Mullholland was elected President and Jas. Crossen, Vice-President. A committee was appointed to see President Van Horne, of the Canadian Pacific, concerning the building and operation of the road.

Frostburg & Bittenger.—A Cumberland, Md., firm will build a narrow gauge railroad from Frostburg to Bittenger, Garrett Co., Md., to tap an extensive timber tract.

SOUTHERN—Existing Roads.

Carolina, Knoxville & Western.—A reorganization of this company was effected at Knoxville, Aug. 5. The property of the Georgia Construction Co., which had the contract for building the road, has been sold to a syndicate of which Jas. U. Jackson, of Augusta, Ga., is President, and John C. Shorter, of New York, Vice-President. Mr. Jackson is Vice-President of the Augusta & West Florida Ry., and Mr. Shorter is President. At the stockholders' meeting Wm. Bailey, of St. Louis, was elected President; J. B. Humbert, of Princeton, S. C., Vice-President, and A. P. Byrd, of Greenville, S. C., General Superintendent. The road was originally projected to extend from Augusta, Ga., to Knoxville, Tenn. About 125 miles were graded and 14 miles of track were laid two years ago but all work stopped at the time the construction company became bankrupt. It is believed that the enterprise will now be carried to completion

East Tennessee, Virginia & Georgia.—It is stated that a cut-off will be built from the tunnel on the main line 5 miles from Chattanooga, to Boyce, on the Cincinnati Southern, thus avoiding the transfer through Chattanooga. The company has assumed control of the Louisville Southern road, recently leased.

Middle & East Tennessee.—J. C. Rodemer, of Gallatin, Tenn., who has the contract for building this road from Gallatin to Hartsville, Tenn., 15 miles, has begun grading. The line is to be ready for trains by Nov. 1.

Missouri, Tennessee & Georgia.—The contractors on this Tennessee road are E. P. Buell & Co., of Tarlton, O., and Robinson & Brickley, of St. Louis, Mo. The road is to extend from Humboldt to Tiptonville, Tenn. The headquarters are at Humboldt.

Kentucky Midland.—The directors propose to extend the road from Paris to the Virginia line, and will submit another proposition for aid to Bourbon Co.

West Virginia & Pittsburg.—Trains are now running to Weston, Lewis Co., and the grading is nearly finished from Weston to Braxton, C. H., and from Weston east to Buckhannon, Upshur Co.

Norfolk & Western.—Proposals are asked for a short extension of the belt line at Lynchburg, Va.——The office of the engineering department of the Ironton extension at Elkhorn, W. Va., has been destroyed by fire with all of its contents.——It is reported that a surveying party is running a line from Bristol, Va., to Kingsport and thence to a connection with the Knoxville, Cumberland Gap & Louisville R. R.——Ground has been broken at Lambert's Point, Va., for extensive car shops to employ about 500 men and cost probably $200,000.

Georgia Southern & Florida.—Tracklaying on the Macon & Birmingham extension is completed from Macon west 82 miles, and will reach La Grange early in September.

Louisville & Nashville.—The line from Blocton to Helena, Ala., 22 miles, has been turned over to the operating department. This includes 12 miles of the Briarfield, Blocton & Birmingham road.——A branch is projected from the Nashville, Florence & Sheffield Ry. to the works of the Napier Mining & Mfg. Co., and surveys are in progress.

Chesapeake & Ohio.—The annual report for the year ending June 30 shows gross earnings of $7,161,000, and net earnings of $1,706,000, an increase of $681,000 over the preceding year. The new equipment purchased during the year was charged to operating expenses.

Genesis & Obed River.—The contract for five miles of this road, near Crossville, Tenn., has been awarded to G. W. Youngs, of Ahnapee, Wis.

Albany, Florida & Northern—Grading has begun on this road, which is to run from Albany to Cordele, Ga., 35 miles The Georgia & Alabama Construction Co., of Cordele, has the contract for the grading. Nelson Tift, of Albany, Ga., is President.

Norfolk Southern.—The line of this road is being relaid with 70 lb. steel, and iron bridges are taking the place of wooden structures. The road will be extended next year to Kingston, N. C.

Savannah, Americus & Montgomery.—Work is in progress on the change of gauge of the line between Americus and Louvale, Ga. Nearly 30 miles are completed and the whole 50 miles will be ready for standard gauge cars by Sept. 20. The Georgia & Alabama Construction Co., which has the contract for the extension from Louvale to Montgomery, Ala., 95 miles, has completed the grading from Louvale to the Chattahoochee River and is now laying track. Grading has begun on the Alabama division.

Alabama Midland.—The locating survey of the Montgomery, Tuskaloosa & Memphis extension is completed to a point 3 miles from Tuskaloosa. The survey of the line from Tuskaloosa to Artesia, Miss., is expected to begin about Sept. 1.

Projects and Surveys.

Autugaville & Northern.—Surveys are completed for this road, which is to extend from Autugaville, Ala., to Booth's Station, 8 miles. M. M. Smith is President and F. C. Faust of Autugaville Chief Engineer.

Brunswick & St. Simon's Coast.—Organized in Georgia by R. H. Hirshfield, Morris Michelsen and others of Brunswick to build a railway from that city to St. Simon's Island, about 25 miles.

Southeastern.—This proposed road is to run from Ft. Valley to Brunswick, Ga., via Cordele, with a branch from Cordele to Hawkinsville. The Cordele Construction Co. is being organized to build the road and will let contracts for the work. F. L. Cawley, Cordele, is interested.

Knoxville Western.—This road will form the Knoxville extension of the Nashville & Knoxville R. R. It will be about 120 miles long. A. W. Schenck, Knoxville, Tenn., is Chief Engineer.

Thomasville, Silver Valley & Pee Dee.—The surveys for this road, which began May 19, have been completed from Winston, N. C., to Wadesboro, 90 miles. A favorable line is said to have been secured, and it is stated that contracts will be let in September. C. W. Pearson is Chief Engineer, and John T. Cramer is President. The headquarters are at Thomasville, N. C.

Tarpon Springs & Tampa.—Incorporated in Florida, to build a railway from the mouth of the Anclote River to Tampa via Tarpon Springs, by Jacob Disston and F. A. Davis, of Philadelphia, and J. M. Vinson, of Tarpon Springs.

Charleston, Wilmington & Norfolk.—The surveying party ha worked from Charleston north to a point in North Carolina. The projectors of the enterprise say that it will shorten the distance between New York and Charleston about 100 miles.

Chattanooga Southeastern.—The promoters of this road, projected to run from Chattanooga, Tenn., to Athens, Ga., about 165 miles are ready to let the contracts for surveys. E. R. Halbert, of Chattanooga, is interested.

Redford & James River.—The survey of this road is to begin soon.

Gadsden, Shelby & Montgomery.—The charter of this company was filed in Alabama Aug. 9.

Ouachita Valley.—This company has been chartered in Alabama to build a railroad from Piedmont to Laney, in Calhoun Co. Jno. E Laney and Columbus Dunn, of Laney, Ala., are interested.

NORTHWEST.—Existing Roads.

Jacksonville Southeastern.—A contract has been closed between the Litchfield, Carrollton & Western R. R. Co., and the Commissioners of the Sny Levee by which the railroad company will extend its line to Quincy, Ill., about 60 miles from its present terminus, along the levee. The railroad company agrees to raise and widen the levee and keep it in repair.

Wisconsin Central.—The contract for the extension from Marshfield to Greenwood, Wis., 20 miles, has been let to S. A. Harrison & Co. This is the first section of the proposed cut-off from Marshfield to Chippewa Falls.

Illinois Central.—A large amount of work is to be done on the division between Ft. Dodge and Sioux City, Ia. Several old trestles are to be filled and heavy grades are to be cut down.

Pacific Short Line.—Surveys have begun from O'Neill, Neb., west, and work on the grading is to be taken up in a few days. J. A. L. Waddell, of Kansas City, is locating the Missouri River bridge. Two or three of the piers will have to be sunk by the pneumatic process. If the quicksand proves unusually troublesome it is intended to try the Poetsch freezing process.

Winona & Southwestern.—Contracts for the 35-mile extension from Stewartville, via Spring Valley and Le Roy, to a connection with the Chicago, St. Paul & Kansas City, were let Aug. 6. J. & C. Mansfield, Mansfield, Dak., have the contract for grading, with headquarters at Spring Valley. D. Van Norman, of Minneapolis, has the contract for the bridging, which includes 3 Howe truss spans. The erection will be done by E. C. Long & Co., of St. Paul. The tracklaying and surfacing will be done by J. N. McInerney. The grading is to be done in 30 days, and the whole work will probably be completed by Nov. 1. On the preceding section tracklaying is in progress, and trains are expected to be running into Stewartville by Sept. 1.

Canadian Pacific.—On the Regina and Long Lake extension it is expected that regular trains will be running from Regina to Prince Albert, N. W. T., by Oct. 1.

Duluth & Winnipeg.—Foley Bros. & Grant, the contractors for this road, have been obliged to quit the work and move their tools and equipment off the Indian reservation.

Port Edward, Centralia & Northern.—The contract for the first 14 miles of this Wisconsin road has been let to J. R. Ryan, who has begun grading. The road is projected to run from Port Edward to Marshfield, 32 miles. T. E. Nash, Centralia, Wis., is President.

Projects and Surveys.

Sioux City & Northwestern.—Mr. A. S. Garretson, of Sioux City, Ia., President of this company, writes us as follows:

Three surveying parties are now at work on this road, which is projected to run from Sioux City northwest to Deadwood or Rapid City, Dak., about 400 miles. The line traverses a heavy rolling prairie country, and its principal traffic will be live stock, farm products and minerals. Capital for construction has been secured by subscriptions to stock, and it expected to let contracts in about 3 months. Mr. L. F. Wakefield, of Sioux City, is Chief Engineer.

Vancouver, Northern & Alaska Ry. & Nav. Co.—At the next session of the Canadian Parliament a company by this name is to be chartered to build a railway from Vancouver, B. C., to Alaska.

Chicago & Lake Shore Electric.—Chartered in Illinois to build an electric railway from Chicago, north along the shore of the lake to Ft. Sheridan, 25 miles, and thence to Waukegan, Wis., by C. H. Remy, Geo. O. Fairbanks, F. L. Brookes and others. The estimated cost of the first 25 miles is $1,500,000, and it is intended to so equip the road that the run from Ft. Sheridan to Chicago can be made in 50 minutes.

Rapid City, Harney Peak & Southwestern.—It is stated that this Dakota road will run a branch into the Bald Mountain gold district.

Black Hills Central.—The surveys are completed for this Dakota road, which is projected to extend from Rapid City to the Wyoming State line, 63.2 miles. Gilbert E. Bailey, of Rapid City, is Chief Engineer.

Randolph & Northeastern Nebraska.—Incorporated in Nebraska to build a railway from Randolph northwest to Fort Randall, So. Dak. The headquarters are to be at Wayne, Neb. Edwin W. Winter, Jas. H. Howe, Thos. W. Moran and others are the incorporators. The incorporation is said to be in the interest of the Chicago, St. Paul, Minneapolis & Omaha company.

SOUTHWEST. Existing Roads.

New Orleans and Northwestern.—Tracklaying is making good progress between Vidalia, La., and Rayville, and only about 20 miles now remains to be laid. The locating surveys are completed for the division between Rayville and the Arkansas line.

Louisiana and Northwest.—General Manager J. D. Beardsley is trying to raise funds to build the extension from Bienville south to Alexandria, La., about 80 miles. The road thus far completed has done a very profitable business.

Texas & Pacific.—A branch from St. James to Napoleonville is projected under the name of the Bayou La Fourche Central.

Houston & Texas Central.—The branch from Hutchins to Lancaster, Tex., has been completed.

Southern Pacific.—The branch of the Galveston, Harrisburg & San Antonio Ry., terminating at Thibodaux, La., is to be extended six miles to a new sugar refinery. The work will begin at once.

Projects and Surveys.

Brownsville, Continental & Northern.—This company has been chartered in Texas to build a railway from Brownsville to San Antonio, 300 miles. The headquarters will be at Brownsville, Tex., and the officers are: Feliciano San Roman, President; Jas. G. Browne, Vice-President; Geo. H. Torre, Secretary.

Camden & Alexandria.—Chief Engineer W. R. Smith states that this line is located from Camden, Ark., to El Dorado, 32 miles, and that contracts will soon be let for this section. The enterprise has been hanging fire for a year and a half. C. C. Henderson, of Camden, is President.

Huntsville & Southwestern.—Preliminary surveys have been made for a railway from Huntsville to Navasota, Tex., 42 miles, by E. H. Wells, of Tyler, Tex. F. H. Ball, of Huntsville, Tex., is interested.

ROCKY MT. AND PACIFIC.—Existing Roads.

Salt Lake & Bountiful.—Mr. H. S. Joseph, of Salt Lake City, Chief Engineer, writes us under date of Aug. 2, that grading has begun on this road, and it will be pushed to completion as rapidly as possible. It is 8 miles in length, extending from Salt Lake to Bountiful.

Oregonian.—This narrow gauge Oregon road, now controlled in the Southern Pacific interest, is being widened to standard gauge. Surveys are nearly completed for an extension of 15 miles from Portland toward Silverton. A considerable change in the present line is contemplated between Silverton and a point southeast of Salem.

Chicago, Burlington & Quincy —Tracklayers are about 25 miles out from Newcastle on the Buffalo, Wyo., extension, and work is making rapid progress. The citizens of Greely, Col., have petitioned the company to build a branch from Raymer to that point, about 40 miles.

Rio Grande Western.—It is rumored that an extension will be built from Spanish Fork, Utah, west via Payson to Tintic, about 40 miles.

Great Northern.—Shepard, Siems & Co., of St. Paul, Minn., who have taken the contract for 180 miles of the extension from Assinaboine, Mont., west, are advertising for contractors, station men, and laborers. The division is all prairie work, except the last 20 miles, where there is heavy work and much rock cutting. They say also:

"Parties going on to our work will be sure of employment on the work to the westward when it is commenced, and that work is expected to occupy three years."

It will be rather surprising if the Great Northern takes so long a time as three years to complete its line to the Pacific Coast.

Denver & Rio Grande.—Grading is practically completed on the Alamosa & Villa Grove branch, 54 miles in length. The contract for the grading of this line was let only 75 days ago.——Work on laying the standard gauge track between Pueblo and Leadville is approaching completion, as is also the Rifle Creek connection. Through broad gauge trains are expected to be running between Pueblo and Salt Lake City by Sept. 15.

Oregon Pacific.—It is rumored that work is to be resumed on the eastern extension of this road.

Atchison, Topeka & Santa Fe.—Three corps of engineers are reported at work between Bakersfield and Rogers, Cal., on the line of the proposed San Francisco extension. The surveys on this division will be finished in about three weeks. A convention is to be called to secure local aid from the counties through which the road will pass.

Southern Pacific.—The work in the Soledad Canon begun last January is finished and opened for traffic. A new line 17.13 miles long has been built to take the place of the old one which gave so much trouble. On the Ventura division 3.25 miles have been rebuilt.——A new survey is in progress for a line through the San Roman Valley, running from Martinez to a point on the Central Pacific near Livermore.——The only stipulation made by the company in its acceptance of the proposition for the completion of the Elwood-Santa Margarita line, noted last week, is that the time limit shall be struck out. A convention is to be called to see if this change will be agreed to.

Union Pacific.—J. R. DeRemer, who has the contract for an extension of 33 miles from Maxwell, near Trinidad, Col., southwest into New Mexico, will complete the line to Catskill before the end of the month For 3 miles across the range the work has been exceedingly heavy. Two cuts containing 46,000 cu. yds. of rock had to be excavated. From Catskill one branch is projected to run via Red River Valley to Las Vegas, while the other turns west toward Elizabethtown.

Manitou & Pike's Peak.—A part of the rolling stock for this line has been received and the road will soon be opened for traffic. L. G. Simmons was the contractor for the line.

Seattle & Montana.—Mr. Wm. P. Watson, of Seattle, Wash., Principal Assistant Engineer of this company, sends us the following information;

This road is to run from Seattle, north along the coast to Marysville, and thence via Stanwood and Mt. Vernon to Fairhaven, where connection is made with the Fairhaven & Southern, which has been purchased by this company, running to New Westminster, B. C. The line is projected also to extend south from Seattle to Portland, Ore., 270 miles. Maximum grades from Seattle north to Skagit are 0.6%. From Seattle to Portland they are 0.8%. About 200 miles have been located, and the contract for the entire work has been let to D. C. Shepard & Co., of St. Paul. The road is to be first class in every respect, and is to be pushed to completion by Jan. 1, 1891. Tracklaying will probably begin about Nov. 1. D. H. Gilman, of Seattle, is President of the company. The road is being built by the Great Northern Ry. Co.

Washington.—A Port Townsend paper publishes the following list of construction work in Washington, stating that the total under construction in that State is now 968 miles:

Fairhaven & Northern—Fairhaven to New Westminster, 30 miles.
Fairhaven & Southern—Sedro to the Skagit, 20 miles; Sedro to Seattle, 50 miles.
Northern Pacific—Durham to Raging River, 18 miles; Almira to Grand Coulee, 30 miles; Centralia to Gray's Harbor, 68 miles; Lakeview to Chehalis, 44 miles.
Oregon & Washington Territory—Centralia to Gray's Harbor, 57 miles.
Port Townsend & Southern—Olympia to Union City, 20 miles; end of track to Quilcene, 32 miles.
Seattle, Lake Shore & Eastern—Snohomish to the international line, 65 miles.
Seattle & Northern—Sedro to the Skagit, 30 miles.
Spokane Falls & Northern—Marcus to Little Dalles, 27 miles.
Tacoma, Ellensburgh & Conconully—Ellensburgh, east, 10 miles.
Tacoma, Olympia & Chehalis Valley—Black River to Gray's Harbor, 49 miles: Centralia to South Bend, 51 miles.
The projected lines or those under survey are as follows:
Bellingham Bay & British Columbia—To the International Line, 10 miles.
Canadian Pacific—Revelstoke to Colville, 175 miles.
Fairhaven & Southern—Seattle to Tacoma, 40 miles.
Northern Pacific—Lake Washington Belt Line, 22 miles; Olympia to Gray's Harbor, 90 miles.
Port Townsend Southern—Quilcene to Union City, 40 miles.

Coos Bay, Coquille & Coast.—Grading has not yet begun on this Oregon road, as stated last week, but contractor Graham is ready to begin work as soon as the locating surveys are sufficiently advanced. It is expected that the line will be completed from Marshfield to Roseburg by Dec. 31.

Pacific Short Line.—Rapid progress is being made on the final location of the Wyoming division of this line, known as the Colorado, Utah & Pacific, and it is expected that the work will be completed by Sept. 1. It is intended to run a branch to Denver.

Projects and Surveys.

Siuslaw & Eastern Ry. & Navigation Co.—Mr. A. G. Hovey, of Eugene, Ore., President of this company, sends us the following information:

This road is projected to run from Eugene, Ore., west to Florence. The distance to the coast is 80 miles and to tide-water in the Siuslaw River is 50 miles. The traffic to be obtained will be principally in lumber, coal, timber, stone, ores and farm products. Preliminary surveys have been made and free right of way has been promised. Further surveys and construction will probably be deferred until next year. J. M. Hodson is Secretary, J. A. Straight is First Vice-President and Alfred Kirkland is Chief Engineer. The headquarters are at Eugene, Ore.

Pecos Northern.—A charter has been filed in New Mexico for this company, which proposes to build a railway from Roswell, Lincoln county, on the Pecos Valley R. R., north and west to a connection with the Atchison, Topeka & Santa Fe R. R. in Bernalillo county. The total length will be about 250 miles. Jas. G. Hagerman and Chas. J. Noble, of Colorado Springs, Col., and S. M. Folsom, of Albuquerque, N. M., are among the incorporators.

Montana Northern.—This company has been chartered in Montana to build a railway from Great Falls to the International boundary. Frank D. Cooper, Chas. M. Blockman, and others are the incorporators.

Tacoma Eastern.—A charter has been granted in Washington Territory for this road. Geo. E. Hart, Chas. Hotchkiss and others, of Tacoma, are interested.

CITY TRANSIT.

Horse Railways.—***New lines*** are proposed at Rockville, Md.

Extensions will be made at East Hartford, Conn., Bay City and Saginaw, Mich., Fort Wayne, Ind., Winona, Minn.

New York City.—Three new companies have applied for charters; one of them wishes right of way across Central Park.

Dummy Railways.—***Atlanta, Ga.***—The Metropolitan Street Ry. is building a line to Decatur, and the Collins Park & Belt Line Co. contemplates a 7-mile line to Collins Park.

Electric Railways.—Extensions will be made at Atlanta, Ga., Nashville, Tenn., Louisville, Ky.

Nashua, N. H.—A line down the Merrimack valley to Lawrence is discussed.

Reading, Pa.—The electric lines will probably be extended to Friedenburg, Pleasantville and Boyertown.

Augusta, Ga.—When the contemplated changes and extensions are made, there will be 40 miles of electric railway here.

Memphis, Tenn.—Work will begin shortly on the electric railway.

Tacoma, Wash.—The electrical railway to Seattle will be 42 miles long when completed, longer than any line previously built.

New Companies.—Troy, N. Y., Electric Street Ry. Co; capital, $20,000. The West Chester Street Ry. Co., West Chester, Pa.; probably electrical. Braddock & McKeesport Electric Ry., Braddock, Pa.; incorporators, J. H. Canfield, J. P. Mill, R. R. Burke and others. Zanesville, O., Street Ry. Co. Metropolitan Electric Ry. Co., Seattle, Wash.; Pres., J. C. Haines; Vice-Pres., G. H. Heilbron; Secy., M. McMicken. Ashtabula, O., Street Railway & Electric Co.; capital, $50,000. Indianapolis & Broad Ripple Rapid Transit Co., Indianapolis, Ind.; Pres., J. Ferguson; Secy., Dr. R. C. Light; capital, $100,000.

HIGHWAYS.

Pennsylvania.—The State Road Commission held meetings in different places during last week. A subcommittee has been appointed to draft a bill for the improvement of the State roads. The general report will be ready in January.

District of Columbia.—Col. Casey of the Engineering Corps, U. S. A., has prepared plans for a new avenue costing $1,122,000 if macadamized, or $1,422,200 if laid with asphalt.

Tennessee.—Delegates from every county in the State will meet in Nashville, Aug. 26, for the purpose of devising some means of improving the highways. The Southwestern Association of Engineers is preparing a plan of highway reform.

Colorado.—A boulevard from Denver to Brighton, a distance of 19 miles, is under discussion.

BRIDGES, TUNNELS AND CANALS.

Bridges—***Waddington, N. Y.***—The proposed bridge across the St. Lawrence near this place seems now likely to be built. Several rival companies have been pushing the enterprise for many years and have been successful only in preventing each other from making any progress. These rival interests have now been harmonized, and books are

to be opened in New York City Oct. 15 for subscriptions to the stock of the bridge company. The engineers of the bridge are Chas. Odell, 2,714 St. Catharine St., Montreal and Walter Shanley, of Montreal, Consulting Engineer Among the directors are Alex. Farlinger, Morrisburg, Ont.; Thos. C. Keefer. Ottawa, Ont., and Dr. Hickey, M. P. for the county of Dundas.

Holyoke, Mass.—The County Commissioners find that the Holyoke and South Hadley bridge will cost about $170,000.

Rochester, N. Y.—A 7-span riveted plate girder bridge is to be built over the Genesee River by the city. Estimated cost $160,000.

Roup, Pa.—The Pennsylvania R. R. will build a bridge across its tracks.

Roanoke, Va.—Only two bids were received for the overhead bridges, and the City Solicitor was ordered to readvertise for bids.

Weston, W. Va.—The Youngstown Bridge Co. has the contract for two bridges.

Montgomery, Ala.—Bids are asked for a bridge of 130 ft. span. until Aug. 22. Address C. A. Allen, Montgomery.

Bastrop, Tex.—A local company is building a steel cantilever bridge across the Colorado River. The cost will be about $45,000.

Peoria, Ill.—The King Bridge Co. has the contract for a bridge over the Illinois River for the Peoria & Pekin Union R. R. Price, $55,200.

St. Paul, Minn.—The City Council has voted to pay $50,000 toward the Selby Ave. cable railway bridge. The total cost wil be $93,000.

Minneapolis, Minn.—Bids will be received until Aug 20 for a railroad bridge over Fifteenth Ave. Address City Engineer Andrew Rinker.

Kansas City.—The Seventh St. viaduct has been completed and accepted. It was built by the Kansas City Bridge & Iron Co. for $70,000.

Vancouver, Wash.—The Union Pacific R. R. will build a railway and highway bridge across the Columbia River for its Portland-Seattle extension. It will have a 470 ft. draw span. Geo. S. Morison is Chief Engineer.

Tunnels.—***Brooklyn, N. Y.***—Supervisor Dunton, of Jamaica, L. I., has engaged an engineer to estimate the cost of the proposed tunnels under Newtown Creek.

Seattle, Wash.—The Front Street Cable R. R. Co. propose to build a 2,000 ft. tunnel. L. H. Griffith, of Seattle, is interested.

WATER-WORKS.

NEW ENGLAND.

Eastport, Me.—It is stated that the Eastport Water Co. will take its supply from Boyden's Lake, in the township of Perry. Direct pumping will be used.

Athol, Mass.—A. MacDonald, Superintendent of the Athol Water Co., has sent us the following:

The new filter is being put in by the Albany (N. Y.) Steam Trap Co. It has a rated capacity of 250 galls. per minute. The above company put in a filter here two years ago.

Holyoke, Mass.—The Whiting street reservoir has just been completed. It is formed by a stone dam 1,900 ft. long and from 10 to 21 ft. high.

East Providence, R. I.—The Riverside Water Co has applied for a 25 years' franchise and hydrant contract to supply water in district No. 3. The town is already partially supplied from Pawtucket.

Meriden, Conn.—A large new reservoir is being discussed, involving the construction of a dam and the expenditure of about $100,000.

MIDDLE.

Dunkirk, N. Y.—The old boiler will be replaced by one of steel of 125 HP.

Ellicottville, N. Y.—A water company has bought a spring with the intention of putting up works.

Gouverneur, N. Y.—The following is from F. S. Pecke, Watertown, N. Y., Engineer :

The contract for the construction of the water-works was let to L. J. Richardson, of Cortland, Cortland Co., N. Y., on Aug. 8, for the sum of $53,000.

Material to be used in the construction will be as follows: Two 1½ and 18½-in. × 11 × 18-in. pumps made by the Deane Steam Pump Co., Holyoke, Mass.; two 60 HP. steel boilers, made by the Phœnix Foundry and Machine Co., of Syracuse, N. Y.; about 6 miles of cast-iron pipe made by the Donaldson Iron Co. and furnished by M. J. Drummond, of New York; 41 hydrants and necessary valves from the Galvin Brass and Iron Works, Detroit, Mich. The water tower will be 30 ft. in diameter and 40 ft. high. Water will be taken from the Oswegatchie River and passed through a filter especially designed by the engineer for the particular requirements of the water commissioners. Spiral weld steel tubing will be used for suction and river crossings, etc. Further particulars will be furnished after and during construction.

Hewlett's, L. I., N. Y.—We are indebted to John Lock wood, New York, President of the company, for the following :

The Hempstead Water Co. intends to begin at once the construction of works to supply about 30,000 people in the villages of Valley Stream, Rockville Center, Pearsalls, East Rockaway, Smithport, Baldwin, Woodsberg, Hewlett's, Ocean Point, Cedarhurst, Lawrence, Isle of Wight and Inwood. The supply will be pumped from wells to a stand-pipe 20 ft. in diameter by 100 ft. high, and there will be 25 miles of pipe. John C. Lockwood is Engineer. Estimated cost, $300,000.

New Rochelle, N. Y.—National filters are to be put in.

Newark, N. J.—A report to the Aqeuduct Board dated Aug. 6, states that work is in progress on the Oak Ridge Clinton and Macopin reservoirs; and that the manufacture of the 48-in. steel pipe was about to be started by the East Jersey Pipe Co. of Paterson.

The Aqueduct Board has just adopted recommendations to the effect that proposals be advertised for furnishing 13 300 ft. of 24, and 1,800 ft. of 12-in. pipe, together with specials, and for laying the same. The pipe is to be used for a new distributing main from the Clifton Ave. reservoir to Walnut St.

Landsowne, Pa.—An effort is being made to secure a better water supply. Probably an artesian well will be sunk. The present works are owned by Casper Pennock, who furnishes water to about 90 dwellings.

Milton, Pa.—The Milton Water Co. informs us that 2½ miles of mains and 40 hydrants are to be added at once

SOUTHERN.

Richmond, Va.—The machinery at the pump-house is to be raised to a higher level.

Key West, Fla.—Contractors will please note the change of date of opening bids, as advertised in this journal, from Sept. 1 to Oct. 1.

Montgomery, Ala.—In accordance with the terms of the franchise the city has the option of purchasing the works from the Montgomery Water-Works Co. on Oct. 7. Mayor Graham favors such a purchase, and the question has been referred by the City Council to their water and judiciary committees and the city attorney.

Louisville, Ky.—The city is advertising for bids for the construction of a well at Broadway and Twenty-third St. The well will be lined with cement pipe.

NORTH CENTRAL.

Coshocton, O.—Bids for boilers and pumping machinery will be opened Aug. 22. E. J. Kuntz is Clerk of the Village Council and Dunham & Paine, of Cleveland, are the engineers.

Huntington, Ind.—In last week's issue we said :

Allen T. Prentice, of Chicago, Ill., Agent for R. D. Wood & Co., has sent us the following: All bids for constructing the new works have been rejected, being too high. The estimated cost was $95,000. The lowest bid received was $120,000.

Jno. W. Hill, consulting engineer for these works writes as follows regarding the above:

This statement is not correct; satisfactory proposals were received for all details of the Huntington, Ind., water-works, excepting pipe-laying, and private tenders are now being received by the company for this, and when a satisfactory contract can be made for pipe laying, all other details will be contracted for under the proposals received at the letting and the construction of the works go forward. The estimated cost was $97,000, and the best tenders including the single proposal for pipe-laying aggregated $109,000. The difficulty with the item of pipe-laying will be reconciled in due time.

Belleville, Ill.—Local capitalists are organizing to purchase the works and rights of the Union Water Co., which were recently sold under a decree of the United States Court for $102,000. At the sale the works were bought by representatives of the holders of the first mortgage bonds.

Peoria, Ill.—The south part of the city is suffering from lack of water, but the company is doing what it can to remedy the trouble.

Chicago, Ill.—The city papers complain of a general lack of water.

Elroy, Wis.—This village of 1,800 inhabitants proposes to issue bonds for works to cost about $10,000. The supply will be pumped from a well to a reservoir. It is not expected that construction will be started before April 1, 1891.

Monroe, Wis.—W. H. Wheeler, Beloit, Wis., President of the Monroe Water-works Co., writes us that the recent reports to the effect that the water is unfit to drink, and that filtration is being considered, are untrue. He says that the only ground for complaint is that the water supply well is not covered.

Superior, Wis.—The Superior Water. Light & Power Co. has completed the laying of its mains across Minnesota Point, and will soon begin on the intake. The water at this place is shallow, and it is reported that it is contaminated by the sewage from Duluth and Superior gathering along the shore, both of which are causes making a long intake necessary if good water is to be secured.

Oshkosh, Wis.—The contract for a new 2,000,000-gall. filter was awarded to the Cumberland Mfg. Co., Boston, Mass.

NORTHWESTERN.

West Duluth, Minn.—The Mayor of Duluth has vetoed the ordinance granting the Duluth Gas & Water Co. the right to supply this place. The veto is on the ground that the company does not give Duluth good service

Benkelman, Neb.—J. P. Israel, Village Clerk, has sent the following:

On Aug. 30 the village wi l open bids for $3,600 of water bonds and for the construction of works. It has been proposed to pump from a well to a tank. J. W. Jones is chairman of the Water Board.

Sutton, Neb.—E. W. Woodruff, Mayor, has sent us the following:

An election to vote water bonds will be held on Sept. 2. If successful it is expected that contracts for works will be let about Sept. 15, and the works be completed by Jan. 1, 1891. The supply will be pumped from wells to a stand-pipe. Estimated cost, $16,000. Engineer, A. A. Richardson, Lincoln, Neb. Population, 1,600.

Fargo, N. D.—The price to be paid by the city for the works will be fixed by three appraisers.

Butte City, Mont.—W. A. Clark, President of the Summit Valley Water Co., sends the following:

The company has already expended $250,000 and desires to issue $100,000 first mortgage, 15-years bonds, to pay for extensions already made which have cost $40,000, for a new pipe line and a large pump, which has already been ordered. The yearly revenue of the company is $69,000, and the operating expenses are but $31,500.

Dillon, Mont.—The water-works survey has been completed and the contracts call for works in operation by Jan. 1, 1891. Seven miles of ditches will convey water from Rattlesnake Creek to a reservoir 400 ft. above the city, from which the supply main will lead.

SOUTHWESTERN.

Independence, Mo.—The Independence Water Co. has sold some bonds and will erect a stand-pipe about three miles from the city, lay some new and relay some old mains. The improvements will cost about $75,000.

Palmyra, Mo.—The Palmyra Light & Water Co. has been incorporated by B. F. Hobart, E. B. Loveland, and others, with a capital stock of $50,000.

Independence, Kan.—L. C. Mason sends us the following:

The company intends to put in a patent filter and a more economical set of pumps; also 2,400 ft. of 4-in. mains.

Bastrop, Tex.—A. B. McLevy has sent the following:

A company proposes to build works costing about $20,000. An attempt will be made to secure a supply from artesian wells. R. L. Batts is Secretary of the committee.

Boulder, Col.—The contract for a part of the extension to the new works [probably the piping] has been let to S. F. Wicks for $5,992.

PACIFIC.

Edison, Wash.—Jno. Deser, President of the Samish Water Supply Co. has sent the following:

These gravity works were completed Aug. 2 at a cost of about $5,000. R. P. Center was contractor. The supply is from Whitehill Creek, 3¼ miles distant. Population, 300.

Dayton, Wash.—Bids will close Sept 15 for $55,000 of 5%., 15-year water bonds. J. A. Kellog is Mayor.

Oregon City, Ore.—Bids and specifications will be received till Sept. 1 for a 1,000,000-gall. water power pump to be driven by a wheel working under a 22 ft. head. The pump must lift water nearly 500 ft. Address, J. W. Connell, Chairman Water Committee.

The Dalles, Ore.—The Water Commissioners are looking for a water-supply at the head of Mill Creek, and will try for an artesian well at North Dalles.

Petaluma, Cal.—A 50,000,000 gallon reservoir is to be constructed by the Petaluma Water Co. on Sohoma Mountain. It is also reported that three new pumping stations are to be erected and that engine, boilers, pipe, etc., are to be purchased.

San Bernardino, Cal.—The following was sent by F. C. Finkle, Chief Engineer:

Last month nine miles of mains were laid for the new works and one-half mile of conduit was completed. Two sides of the reservoir are finished. It is expected that the works will be completed about Sept. 21.

Santa Maria, Cal.—A franchise has been granted to Wm. M. Forrester.

CANADA.

Aylmer, Ont.—Works are projected. The supply will probably be from artesian wells.

Toronto, Ont.—The new intake between the main station and the island has been completed. Additional pumping machinery is badly needed.

West Toronto Junction, Ont.—An extension of the mains has been recommended.

ARTESIAN WELLS.

Boone, Ia.—The well is down 2,600 ft.

Washington, Ia.—The town has contracted for an artesian well to furnish not less than 100,000 galls. a day.

Springer, N. M.—A flowing artesian well has been sunk on a fruit farm near this place.

IRRIGATION.

Ellendale, N. D.—An artesian well is to be sunk by some of the farmers and an experimental attempt will be made to irrigate from it.

Pasco, Wash.—The Board of Directors of the Pasco Irrigation District will receive bids until Sept. 2 for $100,000 of 6% bonds, payable after 15 years in yearly installments of not less than $6,00 , the whole to be paid by the close of the thirtieth year.

Arizona.—Jno. King and W. C. Collier propose to build a dam upon New River, 30 miles northwest of Phœnix. The dam, as projected, will be of stone, nearly a half mile long, 75 ft. high, 320 ft. thick at bedrock. Estimated cost, $300,000. It is expected that the water stored will irrigate 75,000 acres of land.

About 8 miles from the site proposed for the above dam, and over the ridge, the Agua Fria Water & Land Co., of Phœnix, propose to build another dam. This will be across a cañon, the walls of which for 75 ft. in height are about 300 ft. apart. It is said that the dam will be 175 ft. high, and 1,000 ft. long on top, and that the reservoir formed by it will have a capacity of 40,000,000,000 cu. ft. or 295,000,000,000 galls.

SEWERAGE AND MUNICIPAL.

Streets.—*New Streets* have been proposed or ordered at Rochester and Troy, N. Y.; Newark, N. J.; St. Louis, Mo.; St. Paul, Minn.

Grading has been ordered at Brooklyn, N. Y ; Newark, N. J.; Council Bluffs, Ia.; Los Angeles and San Bernardino, Cal.

CONTRACTING.

Boston, Mass.—Metropolitan Sewerage Commission. Bids received Aug. 13 for

Section 8, Main Sewer (9 ft. diam.)

Bidder.	Earth excava. and refill, 9 ft. diam. sewer.	Rock excavation.	Brick masonry, American.	Brick masonry, Portland.	Concrete masonry, American.	Concrete masonry, Portland.	Spruce lumber in place.	6-in. under-drain in place.	8-in. under-drain in place.	10-in. under-drain in place.	12-in. under-drain in place.	Spruce piles driven.	Cobble stone paving	Earth excava., and refilling outside of trench.	Total.
	4,100 lin. ft.	50 cu. yds.	1,650 cu. yds.	150 cu. yds.	4,350 cu. yds.	575 cu. yds.	120 M ft. B. M.	300 lin. ft.	500 lin. ft.	1,600 lin. ft.	1,700 lin. ft.	500 lin. ft.	25 sq. yds.	500 cu. yds.	
R. A. Malone & Son Phila	$10.00	$5.00	$12.00	$13.50	$5.50	$6.50	$30.00	$0 50	$0.60	$0.70	$0.80	$0.20	$1 00	$0.80	$96,792
Met. Cons. Co., Boston	8.25	5.00	6.86	8.78	5.65	7.57	35.00	0.20	0.25	0.40	0.50	0.15	0.30	1.50	82,349
O. P. Roberts, Cambridge.	9.20	2.00	6.75	7.90	5.00	6.35	25.00	0.25	0.35	0.45	0.60	0.20	0.50	0.60	80,946
Charles Linehan, "	8.00	1.00	6.00	7.25	4.00	4.50	24.00	0.50	0.60	0.75	1.00	0.15	1.00	0.75	70,530
Nat'l Cons. Co., Boston...	7.35	1.00	6.05	7.15	4.35	6.00	23.00	0.25	0.35	0.50	0.65	0.15	0.75	1.00	69,121

Section 9 Main Sewer (9 ft. diam.)

	3,700 lin. ft.	50 cu. yds.	2,000 cu. yds.	110 cu. yds	3,500 cu. yds.	450 cu. yds.	125 M ft. B. M.	500 lin. ft.	700 lin. ft.	1,000 lin. ft.	1 500 lin. ft.	500 lin. ft.	25 sq. yds.	500 cu. yds.	
Nat'l Construction Co., Boston	$6.35	$1.00	$6.15	$7.15	$4.35	$6.00	$26.00	$0.30	$0.40	$0.50	$0.65	$0.15	$0.75	$1.00	$60,305
Chas Linehan, Cambridge.	7.75	3.00	6.00	7.25	4.25	5.25	24.00	0.50	0.60	0 75	1.00	0.15	1.00	0.75	65,255
O. P. Roberts, Cambridge..	10.20	3.50	6.95	8.10	5.00	6.35	25.00	0.25	0.35	0.45	0.60	0.20	0.50	0 60	78,321
R. A. Malone & Son, Phila.	12.00	5.00	12.00	13.50	5.50	6.50	30.00	0.50	0.60	0.70	0.80	0.20	1.00	0.80	99,155

Section C Main Sewer (4 ft. 10 in. diam.)

	5,800 lin. ft.	50 cu. yds.	1,400 cu. yds.	100 cu. yds.	2,300 cu. yds.	150 cu. yds.	100 M.ft. B. M.	700 lin. ft.	1,100 lin. ft.	1,600 lin. ft.	2,400 lin. ft.	1,300 lin. ft.	25 sq. yds.	500 cu. yds.	
J. Cavanagh & Co., Boston	$8.90	$3.00	$6.75	$7.75	$6.75	$7.50	$28.00	$0.45	$0.55	$0.65	$0.73	$0 18	$2.00	$8.90	$91,925
Aaron A. Hall, Dorchester	6.85	5.00	7.00	9.45	4.57	5.38	30.00	0 40	0.50	0.60	0.80	0.30	2.25	0.80	73,109
Nat'l Construction Co., Boston	5.90	1.00	7.25	8.00	4.65	5.75	27.00	0.25	0.35	0.50	0.65	0.13	0.75	1.00	64,606

Section D Sewer (4 ft. 10 in. Diam.)

	5,400 lin. ft.	50 cu. yds.	1,500 cu. yds.	100 cu. yds.	2,250 cu. yds.	150 cu. yds.	70 M ft. B. M.	500 lin. ft.	1,100 lin. ft.	1,600 lin. ft.	2,200 lin. ft.	1,500 lin. ft.	25 sq. yds.	500 cu. yds.	
Aaron A. Hall, Dorchester	$6.85	$5.00	$7.00	$9.50	$4.57	$5.38	$30.00	$0.40	$0.50	$0.60	$0.80	$0.30	$2.25	$0.80	$66,256
Charles" Linnehan, Cambridge	5.40	1.00	6.00	7.25	4.00	4.50	24.00	0.50	0.60	0.75	1 00	0.15	1.00	0.75	55,225
Nat'l Cons. Co., Boston....	4.75	1.00	6.75	7.75	4.45	5.50	24.00	0.30	0 35	0.45	0.65	0.15	0.75	1.00	52,546

Waterbury, Conn.—About 3,500 sq. ft. of granite block pavement with pitched joints will be laid.

Newark, N. J.—Grading and curbing costing over $40,000 is under discussion.

Harrison, N. J.—Belgian block pavement will be laid.

Cincinnati, O.—Considerable grading, curbing and macadamizing has been ordered.

Salt Lake City, Utah.—Grading, curbing and asphalt paving has been ordered at an estimated cost of $10,000.

Sewers have been ordered at Manchester, N. H.; Troy and Rochester, N. Y.; Newark and Harrison, N. J.; Pekin, Del.

Toronto, Ont.—Engineer Jennings is preparing plans for the complete sewerage of the city. He intends having 2 trunk sewers emptying into different places on Lake Ontario.

Troy, N. Y.—A number of 30 × 45, 26 × 40 and 32 × 48-in. brick sewers have been ordered.

Buffalo, N. Y.—2½, 2¼, 2 ft. brick and 10, 15 and 18 in. pipe sewers have been ordered.

Rochester, N. Y.—A 2½ × 3 ft. stone sewer costing $41,900 and 12-in. pipe sewers costing $5,500 are proposed.

Jamestown, N. Y.—The Board of Public Works has asked for $95,000 for sewers, $65,000 for paving, and $30,000 for electric lights.

Kansas City, Mo.—City Engineer Betts has completed plans for the second section of the O. K. sewer.

Hastings, Neb.—Work on the sewerage system has begun.

Seattle, Wash.—A 4 × 6 ft. tunnel, costing $35,000, is under discussion.

ELECTRICAL.

Electric Light.—***Meyersdale, Pa.***—A company is being formed.

Orangeburg, S. C., will buy a plant shortly.

Wooster, O.—The Electric Light Co. will increase its plant.

Joplin, Mo.—The Joplin Gas & Coke Co. will buy an arc and incandescent light plant.

New Companies.—Taylor Electric Co., Richmond, Va.: Pres., A. W. Garber; Sec'y., J. E. McKinney. Eaton, O., Electric Light & Power Co.; capital, $20,000. Greensboro, Ala., Electric Light Co.; capital, $5,000. Salem, O., Electric Light & Power Co.; capital, $50,000. Metropolitan Electric Co., Seattle, Wash.; incorporators, J. Furth, A. B. Stewart and others; capital, $3,000,000.

Paving.—***Waterbury, Conn.***—A contract for granite block pavement with pitched joints was recently let at $2.78 per sq. yd.

Hartford City, Ind.—The Talbot Paving Co. of Detroit, Mich., has received a contract of $37,000 for cedar block pavements.

Buffalo, N. Y.—W. H. Albro has a contract of $42,290 for German rock asphalt pavement.

Grading.—***Omaha, Neb.***—A recent contract for street work was let at 19.9 cts. per cu. yd.

Dredging.—***New York City.***—Prices have dropped here, for recent bids were only 12, 16 and 19½ cts. per cu. yd. on contracts with the Dock Department.

Brick.—***Washington, D. C.***—The Washington Brick Machine Co. has a government contract for paving brick at $10.43 per M., and arch brick at $7.93 delivered within city limits, $8.93 in Georgetown, or $9.33 elsewhere.

PROPOSALS OPEN.

Church.—***Atlanta, Ga.***—A. D. Adair, Sept. 10.

Hotel.—***Goshen, Va.***—Stone and brick. C. L. Cooke, care of Goshen Land & Improvement Co., Aug. 27.

Dredging.—***Albany, N. Y.***—About 450 cu. yds. of earth and 2,900 cu. yds. of rock excavation. E. Hanlon Aug. 21.

Pumping Machinery for Water-Works.—***Coshocton, O.***—Dunham & Paine, Aug. 21.

Railroad Work.—***Shelby, Ala.***—About five miles profiles can be seen at the office of Aldrich, Worthington & Co.

St. Paul, Minn.—About 185 miles of the Great Northern Ry., all but 20 miles prairie work; the last 20 miles will have some heavy cuts and rock work. Shepard, Siems & Co.

Water-Works Plant.—***Allegheny, Pa.***—Two pumping engines of 8,000,000 galls. capacity each, two reservoirs, 460 × 660 ft. at the foot of the 30-ft. high embankment, six 60-in. stop gates, a 1,500 HP. boiler plant, a filter plant 8.74 miles of 60-in. steel or iron pipe. E. Armstrong, Oct. 1

Court House.—***Spartanburg, S. C.***—C. A. Barry Aug. 30.

Morgantown, W. Va.—R. E. Fast. Sept. 1.

Bridge Approaches.—***Buchanan, Va.***—Two wooden railway trestles, 400 and 1,000 ft. long respectively and four 250 ft. highway trestles. W. Jolliffe, Aug. 20.

Repairs to Pier.—***New York City.***—Material necessary is estimated at 196,400 ft. B. M. yellow pine, 49,200 ft. spruce and 2,500 ft. white oak timber, 341 pine or cypress piles and 14 white oak piles. 9½ tons of spikes and nails 6½ tons boiler-plate armatures, straps and bolts, 6 tons wrought-iron screw bolts, 34,000 cu. yds. riprap. Dock Dept., Aug. 21.

Dam and Hydraulic Canal.—***Austin, Tex.***—Work involves 17,000 cu. yds. dimension stone masonry, 70,000 cu. yds. rubble stone masonry, 75,000 cu. yds. earth excavation and 55,000 cu. yds. rock excavation. J. P. Frizell, Oct. 15.

Sewers.—***Troy, N. Y.***—E. O. Ross, Aug. 21.

Cleveland, O.—C. G. Force, Sept. 4.

Paving.—***New York City.***—Asphalt on concrete foundation, asphalt block, trap block and granite block, with necessary grading. T. F. Gilroy, Aug. 21.

Washington, D. C.—Grading and paving. J. W. Douglass, Aug. 30.

Cleveland, O.—Medina stone with concrete joints together with necessary grading and curbing. C. G. Force-Aug. 21.

Fort Logan, Colo.—2,900 ft. of red stone flagging Capt. L. E. Campbell, U. S. A., Denver, Colo., Aug. 30.

Reservoir Dams.—***Carmel, N. Y.***—Two earth and masonry dams for reservoir "D" of New Croton Aqueduct system. J. C. Duane, Stewart Building, New York City, Aug 27.

Material for Repairs to Cob Dock.—***Brooklyn Navy Yard.***—Water pipe, railway material, 1,000,000 ft. B. M. yellow pine, 2,800 cu. yds. broken stone, 3 pile driving hoisting engines, 2,900 bbls. Portland cement, 5,000 cu. ft. granite coping, 2 pile drivers, 32½ tons screw bolts and nuts. Paymaster, General E. Stewart, U. S. N., Washington, D. C., Aug. 26.

Steam Pump.—***Oregon City, Ore.***—One million galls. daily capacity. J. W. O'Connell, Sept. 1.

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The Thomson Electric Welding Co. is building large works at Newark, N. J., for welding tubes for ice and similar machines.

New Companies.—Goshen Rolling Mill Co., Goshen Bridge, Va., capital, $300,000. Incorporators, H. Stephen, J. Y. Keckman, both of Philadelphia, and others. Youngstown Iron and Steel Co., Youngstown, O.; capital, $600,000. Tiffany Iron Works, Tecumseh, Mich.; capital, $50,000

Metal Market Prices.—***Rails***—New York: $31 to $31.50 for old iron rails, $24 to $24.50; Chicago: $33.50; old rails, $26.50 to $27 for iron, $19 to $22 for steel. Pittsburg: $31.50 to $32 old rails, $27 to $27.25 for iron; $21.50 to $22.50 for steel.

Foundry Pig-iron.—Chicago : $15.50 to $17.50. Pittsburg: $16.50 to $17.50. New York: $15.75 to $17.50.

Track Materials.—New York: steel angle bars, 1.75 to 1.9 cts.; spikes, $2 to $2.10; track bolts, 2.8 to 3 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron; spikes, 2.01 to 2.15 cts.; track bolts, 2.85 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 cts. for steel, and 2.05 to 2.1 cts. for iron; spikes, 2.15 to 2.2 cts; track bolts 3 to 3.15 cts. with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.35 cts.; Chicago, 4.35 to 4.4 cts.

Structural Material.—Pittsburg : angles, 2.2 to 2.25 cts.; tees, 2.8 cts.; beams and channels, 3.15 cts.; sheared steel bridge plates, 2.7 cts.; universal mill plates, 2.55 cts.; refined bars, 1.90 to 2 cts.; steel plates, 4.3 to 4.8 cts. for fire box; 3.2 to 3.25 cts. for flange; 3.05 cts. for shell, 2.75 to 2.8 cts. for tank. New York: beams, 3.10 cts.; plates, 2.15 to 2.20 cts.; angles, 2.25 cts.; tees, 2.5 to 2.6 cts.; channels, 3.1 cts. Chicago: angle, 2.3 cts.; tees, 2.8 to 2.9 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.

Grading has been ordered at Brooklyn, N. Y; Newark, N. J.; Council Bluffs, Ia.; Los Angeles and San Bernardino, Cal.

CONTRACTING.

Boston, Mass.—Metropolitan Sewerage Commission. Bids received Aug. 13 for

Section 8, Main Sewer (9 ft. diam.)

Bidder.	Earth excav'n, and refill, 9 ft. diam. sewer.	Rock excavation.	Brick masonry, American.	Brick masonry, Portland.	Concrete masonry, American.	Concrete masonry, Portland.	Spruce lumber in place.	6-in. under-drain in place.	8-in. under-drain in place.	10-in. under-drain in place.	12-in. under-drain in place.	Spruce piles driven.	Cobble stone paving	Earth excava. and refilling outside of trench.	Total.
	4,100 lin. ft.	50 cu. yds.	1,650 cu. yds.	150 cu. yds.	4,350 cu. yds.	575 cu. yds.	120 M ft. B. M.	300 lin. ft.	500 lin. ft.	1,600 lin. ft.	1,700 lin. ft.	500 lin. ft.	25 sq. yds.	500 cu. yds.	
R. A. Malone & Son Phila	$10.00	$5.00	$12.00	$13.50	$5.50	$6.50	$30.00	$0.50	$0.60	$0.70	$0.80	$0.20	$1.00	$0.80	$96,792
Met. Cons. Co., Boston	8.25	5.00	6.86	8.78	5.65	7.57	35.00	0.20	0.25	0.40	0.50	0.15	0.30	1.50	82,349
O. P. Roberts, Cambridge.	9.20	2.00	6.75	7.90	5.00	6.35	25.00	0.25	0.35	0.45	0.60	0.20	0.50	0.60	80,946
Charles Linehan, "	8.00	1.00	6.00	7.25	4.00	4.50	24.00	0.50	0.60	0.75	1.00	0.15	1.00	0.75	70,530
Nat'l Cons. Co., Boston...	7.35	1.00	6.05	7.15	4.35	6.00	23.00	0.25	0.35	0.50	0.65	0.15	0.75	1.00	69,121

Section 9 Main Sewer (9 ft. diam.)

	3,700 lin. ft.	50 cu. yds.	2,000 cu. yds.	110 cu. yds	3,500 cu. yds.	450 cu. yds.	125 M ft. B. M.	500 lin. ft.	700 lin. ft.	1,000 lin. ft.	1 500 lin. ft.	500 lin. ft.	25 sq. yds.	500 cu. yds.	
Nat'l Construction Co., Boston	$6.35	$1.00	$6.15	$7 15	$4.35	$6.00	$26.00	$0.30	$0.40	$0.50	$0.65	$0.15	$0.75	$1.00	$60,305
Chas Linehan, Cambridge.	7.75	3.00	6.00	7.25	4.25	5.25	24.00	0.50	0.60	0 75	1.00	0.15	1.00	0.75	65,255
O. P. Roberts, Cambridge..	10.20	3.50	6.95	8.10	5.00	6.35	25.00	0.25	0.35	0.45	0.60	0.20	0.50	0 60	78,321
R. A. Malone & Son, Phila.	12.00	5.00	12.00	13.50	5.50	6.50	30.00	0.50	0.60	0.70	0.80	0.20	1.00	0.80	99,155

Section C Main Sewer (4 ft. 10 in. diam.)

	5,800 lin. ft.	50 cu. yds.	1,400 cu. yds.	100 cu. yds.	2,300 cu. yds.	150 cu. yds.	100 M. ft. B. M.	700 lin. ft.	1,100 lin. ft.	1,600 lin. ft.	2,400 lin. ft.	1,300 lin. ft.	25 sq. yds.	500 cu. yds.	
J. Cavanagh & Co., Boston	$8.90	$3.00	$6.75	$7.75	$6.75	$7.50	$28.00	$0.45	$0.55	$0.65	$0.79	$0 18	$2.00	$8.90	$91,925
Aaron A. Hall, Dorchester	6.85	5.00	7.00	9.45	4.57	5.38	30.00	0 40	0.50	0.60	0.80	0.30	2.25	0.80	73,109
Nat'l Construction Co., Boston	5 90	1.00	7.25	8 00	4.65	5.75	27.60	0.25	0.35	0.50	0.65	0.13	0.75	1.00	64,606

Section D Sewer (4 ft. 10 in. Diam.)

	5,400 lin. ft.	50 cu. yds.	1,500 cu. yds.	100 cu. yds.	2,250 cu. yds.	150 cu. yds.	70 M ft. B. M.	500 lin. ft.	1,100 lin. ft.	1,600 lin. ft.	2,200 lin. ft.	1,500 lin. ft.	25 sq. yds.	500 cu. yds.	
Aaron A. Hall, Dorchester	$6.85	$5.00	$7.00	$9.50	$4.57	$5.38	$30.00	$0.40	$0.50	$0.60	$0.80	$0.30	$2.25	$0.80	$66,256
Charles Linehan, Cambridge	5.40	1.00	6.00	7.25	4.00	4.50	24.00	0.50	0.60	0.75	1.00	0.15	1.00	0.75	55,225
Nat'l Cons. Co., Boston....	4.75	1.00	6.75	7.75	4.45	5.50	24.00	0.30	0 35	0.45	0.65	0.15	0.75	1.00	52,546

Waterbury, Conn.—About 3,500 sq. ft. of granite block pavement with pitched joints will be laid.

Newark, N. J.—Grading and curbing costing over $40,000 is under discussion.

Harrison, N. J.—Belgian block pavement will be laid.

Cincinnati, O.—Considerable grading, curbing and macadamizing has been ordered.

Salt Lake City, Utah.—Grading, curbing and asphalt paving has been ordered at an estimated cost of $10,000.

Sewers have been ordered at Manchester, N. H.; Troy and Rochester, N. Y.; Newark and Harrison, N. J.; Pekin, Del.

Toronto, Ont.—Engineer Jennings is preparing plans for the complete sewerage of the city. He intends having 2 trunk sewers emptying into different places on Lake Ontario.

Troy, N. Y.—A number of 30 × 45, 26 × 40 and 32 × 48-in. brick sewers have been ordered.

Buffalo, N. Y.—2½, 2¼, 2 ft. brick and 10, 15 and 18 in. pipe sewers have been ordered.

Rochester, N. Y.—A 2½ × 3 ft. stone sewer costing $41,900 and 12-in. pipe sewers costing $5,500 are proposed.

Jamestown, N. Y.—The Board of Public Works has asked for $95,000 for sewers, $65,000 for paving, and $30,000 for electric lights.

Kansas City, Mo.—City Engineer Betts has completed plans for the second section of the O. K. sewer.

Hastings, Neb.—Work on the sewerage system has begun.

Seattle, Wash.—A 4 × 6 ft. tunnel, costing $35,000, is under discussion.

ELECTRICAL.

Electric Light.—***Meyersdale, Pa.***—A company is being formed.

Orangeburg, S. C., will buy a plant shortly.

Wooster, O.—The Electric Light Co. will increase its plant.

Joplin, Mo.—The Joplin Gas & Coke Co. will buy an arc and incandescent light plant.

New Companies.—Taylor Electric Co., Richmond, Va.: Pres., A. W. Garber; Sec'y., J. E. McKinney. Eaton, O., Electric Light & Power Co.; capital, $20,000. Greensboro, Ala., Electric Light Co.; capital, $5,000. Salem, O., Electric Light & Power Co.; capital, $50,000. Metropolitan Electric Co., Seattle, Wash.; incorporators, J. Furth, A. B. Stewart and others; capital, $3,000,000.

Paving.—***Waterbury, Conn.***—A contract for granite block pavement with pitched joints was recently let at $2.78 per sq. yd.

Hartford City, Ind.—The Talbot Paving Co. of Detroit, Mich., has received a contract of $37,000 for cedar block pavements.

Buffalo, N. Y.—W. H. Albro has a contract of $42,290 for German rock asphalt pavement.

Grading.—***Omaha, Neb.***—A recent contract for street work was let at 19.9 cts. per cu. yd.

Dredging.—***New York City.***—Prices have dropped here, for recent bids were only 12, 16 and 19½ cts. per cu. yd. on contracts with the Dock Department.

Brick.—***Washington, D. C.***—The Washington Brick Machine Co. has a government contract for paving brick at $10.43 per M., and arch brick at $7.93 delivered within city limits, $8.93 in Georgetown, or $9.33 elsewhere.

PROPOSALS OPEN.

Church.—***Atlanta, Ga.***—A. D. Adair, Sept. 10.

Hotel.—***Goshen, Va.***—Stone and brick. C. L. Cooke, care of Goshen Land & Improvement Co., Aug. 27.

Dredging.—***Albany, N. Y.***—About 450 cu. yds. of earth and 2,900 cu. yds. of rock excavation. E. Hanlon Aug. 21.

Pumping Machinery for Water-Works.—***Coshocton, O.***—Dunham & Paine, Aug. 21.

Railroad Work.—***Shelby, Ala.***—About five miles profiles can be seen at the office of Aldrich, Worthington & Co.;

St. Paul, Minn.—About 185 miles of the Great Northern Ry., all but 20 miles prairie work; the last 20 miles will have some heavy cuts and rock work. Shepard, Siems & Co.

Water-Works Plant.—***Allegheny, Pa.***—Two pumping engines of 8,000,000 galls. capacity each, two reservoirs, 460 × 600 ft. at the foot of the 30-ft. high embankment, six 60-in. stop gates, a 1,500 HP. boiler plant, a filter plant 8.74 miles of 60-in. steel or iron pipe. E. Armstrong, Oct. 1

Court House.—***Spartanburg, S. C.***—C. A. Barry Aug. 30.

Morgantown, W. Va.—R. E. Fast. Sept. 1.

Bridge Approaches.—***Buchanan, Va.***—Two wooden railway trestles, 400 and 1,000 ft. long respectively and four 250 ft. highway trestles. W. Jolliffe, Aug. 20.

Repairs to Pier.—***New York City.***—Material necessary is estimated at 196,400 ft. B. M. yellow pine, 49,200 ft. spruce and 2,500 ft. white oak timber, 341 pine or cypress piles and 14 white oak piles. 9½ tons of spikes and nails 6½ tons boiler-plate armatures, straps and bolts, 6 tons wrought-iron screw bolts, 34,000 cu. yds. riprap. Dock Dept., Aug. 21.

Dam and Hydraulic Canal.—***Austin, Tex.***—Work involves 17,000 cu. yds. dimension stone masonry, 70,000 cu. yds. rubble stone masonry, 75,000 cu. yds. earth excavation and 55,000 cu. yds. rock excavation. J. P. Frizell, Oct. 15.

Sewers.—***Troy, N. Y.***—E. O. Ross, Aug. 21.

Cleveland, O.—C. G. Force, Sept. 4.

Paving.—***New York City.***—Asphalt on concrete foundation, asphalt block, trap block and granite block, with necessary grading. T. F. Gilroy, Aug. 21.

Washington, D. C.—Grading and paving. J. W. Douglass, Aug. 30.

Cleveland, O.—Medina stone with concrete joints together with necessary grading and curbing. C. G. Force-Aug. 21.

Fort Logan, Colo.—2,900 ft. of red stone flagging Capt. L. E. Campbell, U. S. A., Denver, Colo., Aug. 30.

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Structural Material.—Pittsburg: angles, 2.2 to 2.25 cts.; tees, 2.8 cts.; beams and channels, 3.15 cts.; sheared steel bridge plates, 2.7 cts.; universal mill plates, 2.55 cts.; refined bars, 1.90 to 2 cts.; steel plates, 4.3 to 4.8 cts. for fire box; 3.2 to 3.25 cts. for flange; 3.05 cts. for shell, 2.75 to 2.8 cts. for tank. New York: beams, 3.10 cts.; plates, 2.15 to 2.20 cts.; angles, 2.25 cts.; tees, 2.5 to 2.6 cts.; channels, 3.1 cts. Chicago: angles, 2.3 cts.; tees, 2.8 to 2.9 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.

PROPOSALS FOR GRANITE PAVING Blocks, to be used on the Streets and Avenues in the City of Washington, D. C.

OFFICE OF THE COMMISSIONERS,
WASHINGTON, D. C., Aug. 11, 1890.

Sealed proposals will be received at this office until 12 o'clock M. on Thursday, Sept. 4, 1890, for furnishing granite paving blocks, to be used on various streets and avenues in the city of Washington.

Blank forms of proposals and specifications can be obtained at this office on application therefor, together with all necessary information, and bids on these forms only will be considered.

The right is reserved to reject any and all bids or parts of bids.

J. W. DOUGLASS,
L. G. HINE,
H. M. ROBERT,
Commissioners, D. C.

33-3t

PROPOSALS FOR GRANITE CURBING, to be used on the Streets and Avenues in the City of Washington, D. C.

OFFICE OF THE COMMISSIONERS,
WASHINGTON, D. C., Aug. 11, 1890

Sealed proposals will be received at this office until 12 o'clock M. on Thursday, Sept. 4, 1890, for furnishing granite curb, to be used on various streets and avenues in the city of Washington.

Blank forms of proposals and specifications can be obtained at this office on application therefor, together with all necessary information, and bids on these forms only will be considered.

The right is reserved to reject any and all bids or parts of bids.

J. W. DOUGLASS,
L. G. HINE,
H. M. ROBERT,
Commissioners, D. C.

33-3t

Masonry and Excavation.

NOTICE TO CONTRACTORS.

The city of Austin, Tex., will receive bids until 12 o'clock noon of Oct. 15, 1890, for construction of a DAM across the Colorado River and excavation of a HYDRAULIC CANAL near Austin.

Said work involves some

17,000	cu. yds.,	dimension stone masonry;
70,000	"	rubble " "
75,000	"	earth excavation;
55,000	"	rock "

Full information, with specifications and forms for proposals, contract and bonds, may be obtained on application to John McDonald, Mayor, or Jos. P. Frizell, Engineer, Austin, Tex.

JOHN McDONALD, Mayor.

August 6, 1890. 33-4.

Proposals for Furnishing 16-in. Cast Iron Water Pipe and Castings.

OFFICE OF WATER COMMISSIONERS,
NORWALK, Conn., Aug. 15, 1890.

Sealed proposals will be received until 12 o'clock, noon, of Tuesday, the 26th day of August, A. D. 1890, by the Water Commissioners of the Borough of Norwalk, State of Connecticut, for the furnishing and delivering upon the wharf at Norwalk, Conn., designated by said Water Commissioners, five hundred and seventy-five (575) tons of sixteen (16) inch cast iron water pipe, and such other castings as may be needed in connection with said water pipe.

The sixteen (16) inch pipe to weigh 117 lbs. per foot. Not less than one hundred and fifty (150) tons of which are to be delivered on or before Sept. 10, 1890, and the balance to be delivered on or before Oct. 10, 1890.

The pipe is to be first quality in every respect, and subject to the approval of the Water Commissioners.

The commissioners reserve the right to increase or diminish the above quantity of water pipe to the extent of not more than twenty (20%) per cent. of the whole, should they so desire, after receiving bids for the same; they also reserve the right to reject any or all bids.

The proposals must be sealed and indorsed with the name of the bidder upon the outside of the envelope, and addressed to A. H. Camp, Clerk of the Water Board, Norwalk, Conn.

Bidders are required with each proposal submitted to inclose certified check in the sum of five hundred ($500) dollars as a forfeit to the Water Commissioners in case of a refusal to promptly enter into a contract on the part of any bidder to whom the contract may be awarded.

WINFIELD S. MOODY,
J. THORNTON PROWITT,
FREDERICK MEAD,
Water Commissioners.

33-1t

FOR SALE.

Established business of Civil Engineering and Surveying, located on Puget Sound, Wash. Complete notes, maps, instruments and office fixtures. Fine opportunity for young civil engineer. Address ENGINEER, care Engineering News, 33-4t

S. E. NOBLE, Prest. JNO. K. WARE, Secy. and Treas. R. F. CARTER, Supt.

The Anniston Pipe Works,

MANUFACTURERS OF

CAST IRON WATER AND GAS PIPE,

ANNISTON, - - - - ALA.

Especially adapted for the Elevation of Clear, Gritty, Thick, or Acidulous Liquids, Quickly, Cheaply and Efficiently

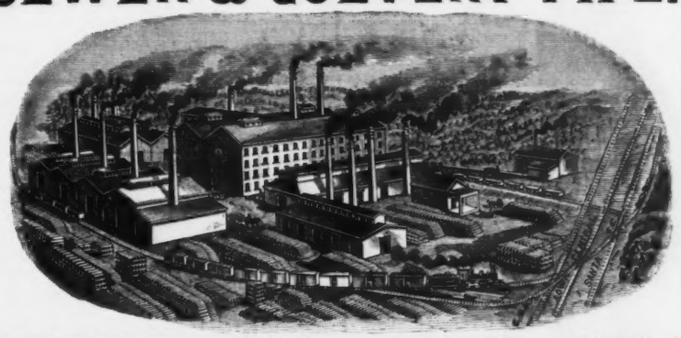
THE NEW PULSOMETER STEAM PUMP.

without Engine, Machinery, Oil, Expensive Power, Skilled Labor, or Material Wear. Send for Illustrated Catalogue.

PATENTED U. S. AND CANADA.

PULSOMETER STEAM PUMP CO., 120 Liberty St., New York.

DOUBLE STRENGTH SEWER & CULVERT PIPE.



MONMOUTH MINING & MFG. CO., MONMOUTH, ILL.

Franklinville, N. Y., Water-Works.

NOTICE TO CONTRACTORS.

Sealed proposals will be received by the Board of Water Commissioners of the village of Franklinville, New York, until six o'clock P. M., of the fourth day of September, 1890, at the office of the secretary of the board, for the material and labor to construct water-works for said village.

Proposals must be made upon blank forms furnished by the commissioners and be accompanied with cash or a certified check or draft for one thousand dollars payable to the treasurer of the Board of the Water Commissioners as a guarantee for the execution of a contract if the proposals shall be accepted. The right is reserved to reject any and all proposals.

Dated Franklinville, N. Y., Aug. 11, 1890.

A. O. HOLMES,
D. W. DEAN,
ALFRED SPRING,
SAMUEL A. SPRING.

ALFRED SPRING, Secretary. 33-3t

Notice to Sewer Contractors.

OFFICE OF SUPT. PUBLIC WORKS,
Room No. 6,
LIBRARY BUILDING, Danbury, Conn.,
Aug. 12th, 1890.

Sealed proposals will be received at this office until 7:30 P. M. Aug. 25, 1890.

For constructing sewers and appurtenances in River and Beaver streets from Elm to Hoyt street, and branches on Highland avenue and Hoyt street.

Blank form of proposals, and any information concerning plans, specifications, bonds, etc., will be furnished upon application.

No proposal will be received after the time specified, and all proposals not on the blanks furnished, or not properly filled out will be rejected.

The right to reject any or all bids will be reserved.

All proposals shall be addressed to the Committee on Sewers, Room No. 6, Library Building, Danbury, Conn.

CHAS. S. PECK,
WILLIAM McPHELEMY,
WILLIAM FOLEY,
Committee on sewers.

33-1t

Proposals for Key West Improvements.

OFFICE OF CITY CLERK,
KEY WEST, Fla., June 2, 1890.

Sealed proposals will be received by the City Clerk of Key West, Fla., until 1st of October, 1890, for furnishing the necessary material and putting in an underground system of sewerage; also for grading and paving the streets of said city and furnishing the material for same; also for furnishing and laying of water mains.

1st. All bids must be made upon the printed forms to be obtained from the City Clerk and inclosed in a sealed envelope, directed to the Board of City Commissioners and marked on the outside of envelope, "Proposals for Key West Improvements."

2d. Each bid must be accompanied by a cash deposit or certified check of five hundred dollars, to be left in the hands of the City Clerk subject to the conditions specified, as a guarantee of the good faith of the bidder.

3d. The city reserves the right to reject any and all bids.

4th. Bidders are requested to be present at the opening of the bids.

5th. Bidders are expected to bid separately on sewer system and material, on grading and paving of streets and on furnishing and laying water mains.

6th. Plans and specifications can be seen at the office of the City Clerk and at the office of Johnson & Flad, Consulting Engineers, Laclede Building, St. Louis, Mo.

WM. L. DELANEY,
City Clerk.

33-5t

To Water-Works Contractors.

Sealed bids for the furnishing of all material and constructing a system of water-works in the city of Algona, Iowa, will be received at the office of the City Clerk until 12 o'clock M., September 1, 1890. Plans and specifications will be on file at the City Clerk's office on and after August 15, 1890. Each bid to be accompanied with a certified check to the amount of $300, as a guarantee that the successful bidder will enter into a contract with said city. The right is reserved to reject any and all bids.

33-2t W. R. QUARTON, City Clerk.

Notice to Contractors for Water Works Plant.

OFFICE OF THE COMPTROLLER,
CITY OF ALLEGHENY, Aug. 7, 1890.

Sealed proposals will be received at this office until 12 o'clock noon Wednesday, October 1, 1890, for doing the following work, viz.:

PUMPING ENGINES.

For the construction and erection of two pumping engines of a capacity of 8,000,000 gallons each, to be of the type known as the vertical direct-acting three-cylinder compound condensing engines, with a combined capacity of pumping 16,000,000 gallons every 24 hours against a head of 300 feet, with a piston speed not exceeding 120 feet per minute.

RESERVOIRS.

For the construction of two basins having 460 by 660 feet surface at foot of embankments, said embankments to be 30 feet above bottom of basins. The reservoirs to have one inlet and one outlet gate chamber.

STOP GATES.

For furnishing six sixty-inch stop gates, to be doubled seated, with parallel-faced valves of easy adjustment, to be operated with two screw stems parallel to each other, and connected by suitable gear.

BOILERS.

For a 1,500 horse-power boiler plant; boilers to be set up in batteries not exceeding 300 horse power, with a given guarantee on evaporative power of boiler per pound of coal consumed. Boilers will be placed in position and set up by the contractor on foundations furnished by the city.

FILTERING PLANT.

Proposals will be received for the construction and erection of a filtering plant to be used in connection with new water service, to be erected at a point nine miles up the Allegheny River. Bidders to furnish their own plans and specifications, erect their plants, and operate the same for a period of not less than six months on trial, and if satisfactory to the Committee on Water and Superintendent of Water-Works, the contract price to be paid; if not satisfactory, they to remove the plant without cost to the city.

CONDUIT AND FORCE MAINS.

For the construction and laying of a 60-inch steel or iron conduit from Nine-Mile Island to the city, about 8.74 miles, to be in sections of 24 ft. in length from center to center of joints. Manholes to be provided for every 40 sections of water main. Elbows for vertical and horizontal inclinations to be provided for, with angles as shown on plan and profile. Force main to be fifty (50) inches in diameter, and constructed as per plans and specifications.

Plans and specifications for buildings, reservoirs, conduit force mains and delivery pipe will be furnished by the city.

Bidders will furnish their own plans and specifications in full detail for engines and boilers, and their connections, with necessary plans for foundations for same.

Proposals will be received for the construction of the whole work, or separately, as bidders may elect.

Plans and specifications may be seen and all information in regard to the above work can be obtained at the office of the Superintendent of Water-Works, and all correspondence in relation to the same should be addressed to Edward Armstrong, Superintendent, City Hall, Allegheny, Pa.

A bond must accompany each proposal to the full amount of the bid, with sufficient sureties for the faithful performance of the contract.

The right is reserved by the Committee on Water to accept or reject bids for the whole or any part of the above work.

JAMES BROWN,
Comptroller.

33-6t

New Court House.

Notice to Contractors.

Sealed proposals will be received by the Commissioners appointed for the purpose by the County Court of Monongalia county, West Virginia, at the office of the Clerk of the Circuit Court, in Morgantown, in said county, until 12 o'clock, noon, on Monday, September 1, 1890, for the labor and material and the construction and completion of a Court House at Morgantown, West Virginia, in accordance with the drawings and specifications furnished by John C. Fulton, Architect, copies of which may be seen at this office.

1st. All bids must be made upon the printed forms to be obtained from this office, in a sealed envelope, directed to the undersigned, and marked "Proposals for Court House at Morgantown, W. Va."

2d. As an evidence of good faith every proposal shall be accompanied by cash or certified check to the amount of three hundred dollars ($300) made payable to the County Court of Monongalia county, in case the successful bidder shall fail, for ten days after an award, to execute the required contract and bond for the faithful performance of the terms of the contract. The checks of unsuccessful bidders will be returned to them immediately after the contract is awarded or all bids rejected.

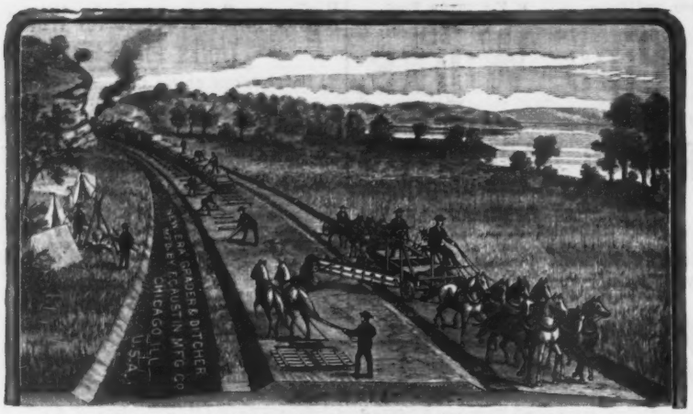
3d. The right is reserved to reject any and all bids.

4th. Bidders are requested to be present at the opening of proposals.

Morgantown, on the Monongahela River may be reached by B. & O. R. R., or from Pittsburg by daily line of steamboats.

R. E. FAST,
Secretary of Commissioners.

32-3t



NEW ERA RAILROAD GRADER AND DITCHER.

Guaranteed capable of placing in embankment *1,000 to 1,500 cubic yards of earth in ten hours*, or of loading *600 to 800 wagons* of 1¼ yards each in same time. This is done with six teams and three men at a cost ranging from 1½ *cents to 2½ cents per cubic yard.*

In writing for catalogue and information please send profile, or write full particulars of work to be done.

F. C. AUSTIN MANUFACTURING CO., CHICAGO, ILL.

RELIANCE
HYDRAULIC JACKS.

SUPERIOR TO ANY JACK NOW MADE.
Absolute in its actions in any position.
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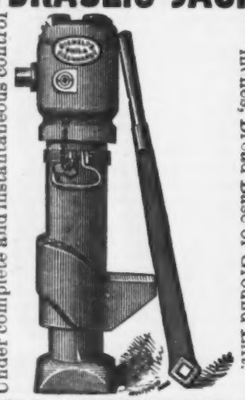

MADE IN FOUR SIZES,
10, 15, 20 and 30 ton capacity, to lift 12 or 18 inches, Broad Base or Ground Lift.

DIENELT & EISENHARDT Mkrs.
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CRAM'S STEAM PILE HAMMER.

The most effective and economical

PILE DRIVING

Machine ever Constructed. **Simple in Design, Easily Operated, not liable to get out of order.** Messrs. Ross & Sanfoad, of Jersey City, say,

"In a day of 10 hours we drove 121 piles with your machine, having an average penetration of 17 feet in sand and oyster shells; and the best days work of 10 hours with the ordinary pile driver was 63 piles."

Manufactured a sold by

R. J. & A. B. CRAM,
80 Griswold St., Detroit, Mich.

WANTED.

To know the present address of Mr. Francis F. Hopp, a civil engineer, and within a year a resident of Birmingham, Ala.

BUFF & BERGER,
28-8t Boston, Mass.

FOR SALE.

Full set of 102 zinc Railroad Curves, from 5¼ inches to 300 inches radius. Bevelled edges absolutely correct. Will sell cheap.

Address,
L. T. ALDEN, C. E.,
FORT PAYNE, ALA.

TO LET.

The laying of 1,400 cu. yds. Heavy Granite and Limestone Masonry in Mississippi River at this place. Will furnish material and plant to right man.

McCORMICK & O'MEARA,
33- 901 Olive St. St. Louis, Mo.

FOR SALE.

Steam Shovels, Light Rails, Dump Cars, Hoists, Drills, Compressors, Electric Light Plants, Ice Machinery, Tanks, all kinds, Crushers, Pile Drivers, Scows, Saw Mills, Narrow Gauge Locomotives, Motors, Contractors' Tools and Machinery of all kinds, second hand and new.

W. S. MIDDLETON,
52 John St., - - NEW YORK.

BUY your BOOKS from

Engineering News Pub. Co,

The "want" advertising is reaching very large proportions. We hear of a man who was dying of consumption, and the publication of one "want" advertisement in the *Whanger* restored him to complete health. Another man lost his wife by elopement with a business rival, and a single line to her in the columns of the *Slanger* brought her to his arms with her honor and affections as good as new. A cashier went to Canada with funds belonging to somebody else, and five lines in the *Push* sent him to prayer-meeting and made him feel like a man with a clear conscience. A milkman advertised for help, and since then he keeps as clear of pumps as if he had the hydrophobia and ~~some~~ measles.—*Judge.*

Vertical Pumps.

CINCINNATI, O., July 31, 1890.

Sealed proposals will be received at the office of the Board of Public Improvements until 12 o'clock noon, Aug. 23, 1890. For four vertical pumps of five million capacity each in twenty-four hours. These pumps to take the place of similar size Wetherell pumps now in position, and to be operated by the steam ends now in use. Each bidder is requested to examine and measure the pump well, and so design his work as to properly connect with the parts to be retained. Each bidder will furnish his own plans, drawings and specification, with guarantee as to date of completion, and forfeiture for failure in duty.

For further particulars apply to Willis P. Tharp, Superintendent and Engineer in charge of City Water-Works.

The Board of Public Improvement reserves the right to reject any or all bids.

By order of the Board of Public Improvements. LOUIS REEMELIN, President.
Attest: A. P. BUTTERFIELD, Clerk B. P. I.
32-2t

Pumping Engines.

CINCINNATI, O., July 31, 1890.

Sealed proposals will be received at the office of the Board of Public Improvements until 12 o'clock noon, Aug. 23, 1890, for two Compound Duplex Pumps—capacity six millions each in twenty-four hours—each bidder to furnish his own plans, drawings and specification; also, guarantee as to time of delivery and forfeiture for failure in duty. Working pressure to be one hundred pounds and steam pressure to be one hundred and fifteen pounds. Engines to be used non-condensing, but so arranged as to work condensing in the future.

For further particulars apply to Willis P. Tharp, Superintendent and Engineer in charge of the City Water-Works.

The Board reserves the right to reject any or all bids.

By order of the Board of Public Improvements.

LOUIS REEMELIN, President.
Attest: A. P. BUTTERFIELD, Clerk. 32-2t

SITUATIONS VACANT.

WANTED.—To add to office force in large shops in Chicago, one or two Draftsmen experienced in Corliss and general engine designing; also, one or two Draftsmen experienced in mill building constructions and general machinery. Address C. F., care Engineering News. 26—

WANTED.—A first-class topographical draughtsman, one especially skilled in relief work, either pen or tint. Must be quick and reliable. Address (enclosing specimen of work and stating salary expected) NIER, HARTFORD & MITCHELL, Chattanooga, Tenn. 29-

WANTED.—Two or more graduates having had professional experience, to fill vacancies in the corps of Assistant Professors in the College of Civil Engineering, of Cornell University. Good salary and prospects for suitable candidates. Address correspondence to Professor E. A. FUERTES, Director, Ithaca, N. Y. 29-6t

WANTED.—A competent party to make some test borings for a tunnel line in Pennsylvania. Address "TEST BORING," care ENGINEERING NEWS. 32-2t

WANTED.—A thoroughly competent superintendent for foundry and machine shop in a large Western city. State experience, references and salary expected. Address A. B. HENRY, 4021 Morgan Street, St. Louis. 32-2t

WANTED at once, two draughtsmen, able to handle iron building and roof construction. Good positions to good men. Apply or address POTTSVILLE IRON & STEEL CO., Pottsville, Pa. 32-2t

WANTED.—A competent draughtsman to make shop and picture plans, highway bridge work A permanent position for first class man. Apply by letter only, giving references. Address DEAN & WESTBROOK, N o. 32 Liberty St. 32-4t

WANTED.—Four good bridge draughtsmen. None but men of experience in working drawings for this class of work need apply. THE BERLIN IRON BRIDGE CO., East Berlin, Conn. 33-2t

WANTED.—Graduate Fellowship, Vanderbilt University—A Graduate Fellowship in Engineering for the next session of the Vanderbilt University will be awarded Sept. 1, 1890. The duties will be the prosecution of advanced studies in engineering and a certain amount of assistance in the engineering laboratories and field-work. Salary, three hundred dollars ($300) and free tuition and quarters. Applicants will be required to submit a statement of and testimonials to their qualifications before the date named. For further information address

O. H. LANDRETH, Dean,
33-3t Nashville, Tenn.

WANTED.—Thomas M. Jacks, City Engineer of Helena, Ark., wants an engineer of experience to assist in the resurvey of the streets, squares, etc., of the city of Helena, Ark., embracing about 800 acres of land inhabited by 8,000 people. Applicants please address THOMAS M. JACKS, City Engineer, Box 17, Helena, Ark. 33-4t.

MISCELLANEOUS.

WANTED.—A second-hand rotary pump, capable of delivering from 600 to 1,000 gallons per minute. Address, stating price, kind and condition, S. L. WILEY, Omaha, Neb. 32-2t

WANTED.—Capitalists to invest in the manufacture, and to form companies to manufacture and to procure franchises to build water-works o the best water pipe and patented joint now in operation. To those wishing to become interested a strict examination of the pipe and joint is solicited. For particulars enquire of CHAS. T. LEONARD, Norwalk, Conn. 32-5t

WANTED.—Engineer's Transit, with level attachment, reading 20 or 30 seconds. Address, with particulars and price, CITY ENGINEER, Springfield, Mass. 33-2t

$20 REWARD for return of Transit stolen from buggy at my office, 91 Washington St., Chicago, November last. Made by Benj. Pike's Sons. Has full circle, vertical arc, with F. C. R. stamped in compass box. F. C. ROSSITER. 33-3t

Surveyors, take Notice!

To the person sending the best and most practical solution, for use in the field, of the following problem relative to a line of highway, I will give a copy of the fifth revised edition—now in press—of the *Manual of Land Surveying* (Bellows and Hodgman) as soon as out.

The field notes of a line of highway read as follows: Commencing at Meander Post No. 5, and running thence N. 62°. E. 14,00 chains; 2d N. 43½°, E. 8,00 chains; 3d N. 5°. W. 12,00 chains; 4th N. 73½°, E. 10,25 chains; 5th S. 12°. W. 6,48 chains, to a stone set for Meander Post No. 8. I commence at Meander Post No. 5, and with variation 2° 17' E. run a random line according to the field notes, setting temporary stakes at each angle in the line, and come out 62 links east of Meander Corner Stone No. 8. 1. What is the correction for the variation of the needle? 2. What is the correction for the stake at each angle, and how shall I find it?

Solutions are to be sent to the editor of Engineering News and the award made by the editors on or before Oct. 1, 1890. If two or more similar best solutions are received a copy will be given to each of the two first received.

F. HODGMAN,
Author and Publisher.
CLIMAX, Mich., July 9, 1890, 29-1t

50 Cts. **WANTS.** 50 Cts

Cards of not more than one-half inch will be inserted in this column one time for 50 cents.

SITUATIONS WANTED.

WANTED.—An engineer, with seven years' experience as assistant on water-works, city and railroad work, a graduate of Lehigh, is open for an engagement in which there is some hope of permanence. An accurate neat and rapid draughtsman; has served in the capacity of office engineer for a large corporation. Field and office instruments. Highest testimonials from present and past employers. Office work in the South preferred. Address "ARET," Engineering News, 30-4t

WANTED.—Position by an engineer (30) experienced in railroad location and construction of heavy work, as tunneling, rock work, foundations, masonry, bridge erection and maintenance of way. Best of references. Address CIVIL ENGINEER, P. O. Box 568, Albuquerque, N. M. 31-3t

WANTED.—A civil engineer, 31 years old, graduate of a technical school, and with a varied experience, mostly on railroads, desires to ally himself with a good practising civil, mechanical or mining engineer in any good sized town of the United States. Address T. S. E., care of Jas. K. Gracie, 80 Broadway, New York. 31-3t

WANTED.—First class draughtsman with spare time will take work from engineers who desire maps neatly and correctly drawn. New York and vicinity preferred. Address "MAPS," care ENGINEERING NEWS. 32-2

WANTED.—A position by a young graduate civil engineer. Office and field experience. References. Address GRADUATE, care Engineering News, 32-2t

WANTED.—A civil engineer and draughtsman of 15 years' experience on location and construction of railroads and water-works, wishes a position. Services available about Sept. 1. Tunneling and masonry specialties. Topography, etc, "X.," care Engineering News, 32-4t

WANTED.—A position in charge of surveys or construction; water-works or sewerage preferred; or a position likely to be permanent with a city engineer or engineering firm. Salary not less than $100 per month. Can furnish instruments and am good draughtsman. Good experience and first-class references. At liberty about Sept. 15. Address E. N. P., care ENGINEERING NEWS. 32-4t

WANTED.—Engineer having experience—railway location and construction, water-works, etc. —desires to find employment with parties in New York City or vicinity, where there is chance of permanent position. Reference. F. D., ENGINEERING NEWS. 32-6t

WANTED.—An experienced draughtsman on structural and architectural iron work. Address Box No. 45, Engineering News, 33-1t

WANTED.—Young civil engineer having six years' experience in general engineering desires permanent position. Address "H.," Box 717 Trenton, N. J. 33-1t.

WANTED.—Opening by young man, college graduate, and technically educated in engineering and chemistry. Some practice as draughtsman and stationary engineer. Paper or wood pulp business preferred. Address Box 293, Andover, Mass. 33-1t

Engineers and Surveyors who do not steadily employ a draughtsman can have their draughting done; also, all extra work they may have attended to by an experienced Draughtsman who has open'd an office for that purpose. Drawings, etc., sent by mail or express. Reference. Address FIELD BOOK, Engineering News, 33-2t

WANTED.—A civil engineer with ten years experience principally on city work would like to secure an engagement lasting from four to six months beginning about October 1. Have been five years on New York City work; been assistant engineer of an Eastern city of 40,000; city engineer of another place for two years, besides having a large practice on other general work. Can make surveys, plans and take charge of construction of works of sewerage and anything under the head of city engineering, and am an expert on the most accurate city surveying. Am also an A1 map draughtsman and can send sample of work. Some railroad experience. Can furnish my own instruments. At present in Wisconsin. Address CITY ENGINEER, care of Engineering News, 33-4t

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Tables for Estimating the Cost of Laying Cast Iron Water Pipe, By Edmund B. Weston, Engineer in Charge of Water Department, Providence, R. I. Price, 50 cents. Published and for sale by Engineering News Publishing Co,